Attachment 2
Mutipathway Risk Assessment

MULTIPATHWAY RISK ASSESSMENT FOR THE KEYSTONE CEMENT COMPANY FACILITY BATH, PENNSYLVANIA

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Health and the Environment

SCIENCES

EXECUTIVE SUMMARY

Project Background

A multipathway human health and an ecological risk assessment was conducted for the Keystone Cement Company (Keystone) cement kilns located in Bath, Northampton County, Pennsylvania. The purpose of the risk assessment was to confirm that hazardous waste derived fuel (HWDF) handling, storage, processing and burning operations at the Keystone facility do not effect the health of the surrounding community or the local environment. The analysis was prepared in connection with the Second Partial Consent Decree in Keystone Cement Company v. Commonwealth of Pennsylvania (EHB Docket Number 95-151-M6) entered by the Environmental Appeals Board on March 11, 1997. The risk assessment was conducted following methods described within both a protocol approved by the Pennsylvania Department of Environmental Protection (PADEP) and the State's January, 1993 *Risk Assessment Guidelines for Facilities Burning Hazardous Wastes* ("PADEP Guidelines") (PADER, 1993).

Facility Information

Keystone's cement production operations consist of two distinct components: 1) the production of clinker (the primary constituent of cement); and 2) the grinding of clinker into cement. HWDF is utilized as a permitted substitute for conventional fuel in clinker production and is, therefore, the primary focus of the risk assessment. The Keystone facility operates two wet process cement kilns. The kilns each have their own exhaust stack and operate under PADEP air quality construction and operating permits. Emissions from each kiln stack are controlled by the following features:

- Air pollution control equipment installed at both stacks includes a multiple cyclone centrifugal collector followed by an electrostatic precipitator (ESP), which collects fine dust particles that are generated in the production process. The ESPs are designed to meet PADEP particulate matter emission limits.

- Thermal removal of organic compounds in each cement kiln is achieved through optimal combustion conditions, which include long residence times, high temperatures, and turbulent mixing. The conditions significantly exceed EPA requirements for hazardous waste incineration facilities.

- Continuous monitoring of the burning zone temperature, carbon monoxide, nitrogen oxides, and opacity to ensure optimal combustion conditions.

The kilns can burn a variety of fuels including coal, coke, fuel oil, natural gas, and non-hazardous and hazardous waste derived fuels in pumpable form. Keystone is permitted by PADEP and the U.S Environmental Protection Agency (EPA) to store liquid HWDF onsite. The storage area currently consists of four aboveground storage tanks with a combined capacity of 93,000 gallons. The existing aboveground storage tanks are constructed of carbon steel utilizing welded construction and API Standard 650. The tanks are supported by a concrete mat with containment walls which are, in turn, supported by a reinforced concrete floor. The concrete floor and surrounding walls form the secondary containment should there be a rupture of any of the tanks. The floors and walls are coated with epoxy to limit the infiltration of any spilled HWDF. The containment area surrounding each of the HWDF storage tanks is capable of retaining an accidental spill volume equivalent to 100% of the largest vessel or tank within the area plus the collected rainfall for a 25-year, 24-hour storm. Additionally, each of the tanks is of fixed roof design and equipped with an explosion vent, conservation vent, and a top mounted agitator to limit the potential for releases to the environment.

All four existing HWDF storage tanks are monitored by an overfilling protection system composed of high level indicators, which signal an audible and visual alarm to the facility Control Room and unloading pad. Additionally, each tank is also equipped with high warning level alarms. Each of the HWDF storage tanks and the associated piping systems are subject to the RCRA 40 CFR 265 Subpart BB (EPA, 1997a) regulations. Consequently, they have identification numbers, locations, and throughput material information, in addition to the leak detection and repair programs. In accordance with requirements of 40 CFR 264 Subpart CC (EPA, 1997b) all vapors from the four existing tanks are to be fed directly into the operating kilns.

PADEP has permitted the facility to construct additional aboveground tanks to increase liquid HWDF storage capacity by 180,000 gallons. Similar to the construction of the existing HWDF storage tanks, the planned tanks will be located in a containment area in the vicinity of the current storage tanks and will be constructed, operated, and monitored in a manner equivalent to that of the current storage tanks.

PADEP has also permitted the facility to construct a 300 cubic yard capacity bulk solid HWDF storage tank, and four bulk solid storage bins with a combined capacity of 600 cubic yards, within an onsite Solids Handling Building. The tank will be protected from precipitation and wind dispersal by the roof and walls of the building. Since only solids without free liquids are to be stored in the tank, secondary containment is not required by the regulations but will nonetheless be included. The planned bulk powder storage tanks will likely be subject to Subparts BB (EPA, 1997c) and CC (EPA, 1997b) of 40 CFR Part 264, due to the potential for volatile organic (VO) concentrations in the HWDF to exceed the Subpart CC exemption level. Therefore, vents in the Solids Handling building will feed any vapors emanating from the bulk solid HWDF storage tank directly into the kilns.

At the current time, HWDF is shipped to the site in single unit tank trucks. While not currently utilized for this purpose, Keystone also has the ability to receive HWDF via rail car. In order to comply with BIF regulations and the State permit, Keystone samples each load of HWDF prior to unloading and analyzes for BTU value, chlorine content, and the concentration of 10 BIF regulated metals. The measured values are compared against pre-determined permit limits to determine whether the HWDF is acceptable. If any of the contaminant levels exceed the acceptable level, the waste derived fuel is rejected. Accepted loads are pumped to one of the storage tanks described above. If in the future Keystone applies for and receives authorization to blend, the facility will mix fuels within onsite storage tanks to meet the conditions acceptable for firing in the kilns. Once a tank of waste derived fuel is determined to be "kiln-ready", it is fired to one of the cement kilns and the feed rate is continuously monitored and recorded. In addition, the feed rate and chloride content of the raw feed streams (cement slurry and coal) are also monitored. All of the data on feed stream contaminant levels and feed rates are entered into a computer tracking system to verify compliance with currently applicable permit limits.

Site Setting

The Keystone facility is located in Bath, East Allen Township, Northampton County, Pennsylvania, approximately 6 kilometers west of Nazareth, and 10 kilometers north of Bethlehem. Based on 1990 U.S. Bureau of Census data, the total population residing within 20 km of the facility is estimated to be 1,003,660. According to the 1994 update and 1999 forecast, it is anticipated that this population base will increase in number.

The land surrounding the Keystone facility consists of rolling hills in a primarily rural and agricultural setting. Substantial industrial and commercial activity exists within 20 km of the facility. The closest residential areas are located just over 200 m to the east of the cement kiln stacks. Local fruit and vegetable gardens exist in the area. Agricultural land located adjacent to the Keystone facility is primarily used for the growth of corn and soybean crops to be used as animal food supplies. Limited growth of oats, rye, and barley crops also occurs within the area.

Maple Grove Farm, located over 2 km to the southeast of the Keystone facility, is the nearest subsistence animal farm and is the only animal farm identified within 5 kilometers of the facility. It is a dairy farm that reportedly also produces corn and soybean crops for animal feeding purposes. The land-use patterns and the location of Maple Grove Farm are shown on Figure ES-1. In addition, the locations of potentially sensitive receptors, such as schools and hospitals, are identified on Figure ES-1.

The Borough of Bath, located directly adjacent to the Keystone facility, reports that two deep groundwater wells act as the sole source of potable water for the local community. As shown on Figure ES-1, Monocacy Creek is the primary surface water body in close vicinity to the site. Three reaches of the Monocacy Creek are stocked from March to May of each year with trout. The Monocacy Creek is reportedly used exclusively for recreational fishing purposes. Several surface water bodies in the area are used for recreational swimming purposes. These include Dutch Springs Quarry, Evergreen Lake, Minsi Lake, Prevaleros Lake, the Delaware River, the Lehigh River, and the Old Lehigh and Delaware Canal. The nearest of these surface water bodies is Dutch Springs Quarry, which is located just over 5 kilometers to the southeast of the Keystone facility.

Potential Public Health Concerns

Despite the controls and safeguards at the facility, it is important to determine whether facility operations may raise concerns with respect to local public health. The potential for adverse health effects were addressed in this risk assessment by evaluating specific scenarios through which specific groups of the local population could potentially be exposed. To ensure that the risk assessment did not underestimate potential health concerns, these scenarios were developed in accordance with PADEP's Guidelines to provide an upperbound estimate of potential chronic (i.e., long-term) and acute (i.e., short-term) health risks. To accomplish this goal, conservative methodologies and data were used to characterize both potential emissions from the Keystone facility and the potential for exposure to concentrations associated with these emissions for each of the scenarios evaluated. These conservative assumptions are made in risk assessment to ensure that data gaps do not lead to an underestimation of actual estimates of human health risk (i.e., to err on the side of protecting public health). The methodologies and data were presented to PADEP (Sciences International Inc., 1997) and incorporated into a PADEP approved risk assessment protocol, which was made a part of the Second Partial Consent Adjudication.

The chronic and acute exposure scenarios evaluated in the risk assessment can be summarized as follows:

- Chronic Plausible Maximum; which uses conservative (i.e., health protective) maximum annual average process emission rates to estimate annual average ambient air concentrations. These concentrations are then combined with conservative exposure assumptions and chronic toxicity factors to estimate long-term (i.e., chronic) risk to members of the surrounding community. Both stack and fugitive emissions are evaluated under this scenario.
- Acute Normal Maximum Operation; which uses conservatively derived maximum short-term (one-hour) process emission rates to estimate maximum one-hour average ambient air concentrations. These concentrations are compared to conservatively derived acute toxicity criteria to estimate the potential for short-term health effects in the surrounding community. Both stack and fugitive emissions are evaluated under this scenario.
- Acute Upset Event; which uses conservatively derived maximum short-term (one-hour) process emission rates under upset operating conditions (i.e., pollution control equipment malfunction) to estimate maximum one-hour average ambient air concentrations. These concentrations are compared to conservatively derived acute toxicity criteria to estimate the potential for adverse short-term health effects in the surrounding community. Both stack and fugitive emissions are evaluated under this scenario.
- Acute On-Site Accident; which uses conservatively derived emission rates associated with a hypothetical storage tank failure and a hypothetical tank truck accident to estimate maximum one-hour average ambient air concentrations. These concentrations are compared to conservatively derived acute toxicity

criteria to estimate the potential for adverse short-term health effects in the surrounding community should these low probability/high potential impact events occur.

- Acute Catastrophic Event; which uses conservatively derived emission rates associated with a HWDF storage tank fire to estimate maximum short-term ambient air concentrations. These concentrations are compared to conservatively derived acute toxicity criteria to estimate the potential for adverse short-term health effects in the surrounding community should this low probability/high potential impact event occur.

The chronic toxicity factors (cancer slope factors and non-cancer reference doses and reference concentrations) used in the evaluation of plausible maximum risks were primarily derived from EPA databases. The Integrated Risk Information System (IRIS) (EPA, 1997d), which is a regularly updated on-line database maintained by EPA, was used as the primary source of chronic toxicity data for many commonly detected substances. The secondary source of chronic toxicity values was the Health Effects Assessment Summary Tables (HEAST) (EPA, 1995a), which EPA also updates regularly. The average inhalation cancer slope factor of all stack-related chemicals was derived and applied to chemicals detected during the 1995 BIF recertification and 1996 compliance tests for which EPA has not developed chronic toxicity data. This step was taken to conservatively account for the potential toxicity of these chemicals.

The acute toxicity criteria (ATCs) used in the evaluation of potential effects associated with short-term (acute) exposures were derived from a variety of government and health agency sources, following PADEP's proposed approach. The ATCs were based on air concentrations known to be below the concentration expected to result in negative health outcomes following short-term elevated exposures. However, in developing the ATCs, these concentrations were further reduced in magnitude so as to provide an additional margin of safety. In the risk assessment, the potential for acute risks was evaluated by comparing the ATCs to the concentrations predicted at the maximum ambient impact point for each of the acute exposure scenarios evaluated (i.e., normal maximum operation, process upset event, onsite accident, and catastrophic event).

The plausible maximum chronic health risk evaluation considered potential carcinogenic and noncarcinogenic outcomes due to long-term exposures to both stack and fugitive process emissions. To conservatively evaluate potential chronic risks to the surrounding population, risks to subpopulations with high-exposure potential were developed. These subpopulations were:

- Resident adults and children who remain at home all day, where they inhale emitted constituents in the ambient air, incidentally ingest constituents deposited on garden soils, and uptake constituents from garden soils via dermal absorption. In addition, these individuals are also assumed to grow a substantial portion of their own fruits and vegetables, drink and eat a substantial diet of milk and milk products produced at the nearest subsistence farm (i.e., Maple Grove Dairy Farm), eat a substantial fraction of their diet of animal products that are assumed to be raised at Maple Grove Farms and, for adults, eat a substantial fraction of their total fish diet from fish caught in Monocacy Creek. It is assumed that these individuals also swim frequently in the nearest recreational water body (Dutch Springs Quarry). Finally, it is assumed for residents located outside the Borough of Bath that drinking water is derived from surface water supplies.
- An aggregate of the adult and child exposure in which a mother is exposed for 25 years as an adult via all of the potential exposure pathways described above, gives birth and breast feeds an infant who potentially extracts emission-related contaminants from breast milk. Furthermore, for upperbound exposure to residents and farm families, post-infancy the individual is assumed to be exposed for an additional 44 years as an adult. Similarly, for high-end exposure to residents and farmers, post-infancy the individual is assumed to be exposed for an additional 30 (resident) or 40 (farmer) years as an adult.
- Farming adults and children are exposed in the same manner as the resident adults and children.

The primary distinctions between these subpopulations and individuals within these subpopulations (i.e., adults and children) are the frequency and the duration of potential exposures (as represented by the number of years they are exposed), the amount of air they inhale, the amount of soil they incidentally ingest and dermally absorb, the amount of home and locally grown fruit, vegetables, meat, milk, fish etc. they ingest, and their location with respect to the Keystone facility. Additionally, as alluded to above, within each of the adult resident and farmer subpopulations, differing exposure frequencies and durations are considered so as to define an upperbound and a high-end exposure. The upperbound exposures were developed in accordance with the PADEP approved risk assessment protocol and PADEP's Guidelines to represent a risk that "... would likely be substantially greater than the actual risk expected from the operation of the hazardous burning unit" (PADER, 1993). To provide a more realistic, yet still health-protective estimate of exposure, an estimate of the "high-end" exposure to individuals (adults and children) in the upper end of the exposure distribution of the population subgroups was made according to current EPA exposure factor guidelines (EPA, 1992; EPA, 1995b).

By evaluating the potential upperbound and high-end risks to individuals within the resident subpopulation assumed to be located at the maximally impacted offsite location, the entire residential population in the area surrounding the facility is expected to be protected if the risks to these maximally exposed residents are within acceptable levels. Similarly, by evaluating potential upperbound and high-end risks to individuals within the farming subpopulation assumed to be located at the maximally impacted subsistence farm location, the entire farming population in the area surrounding the facility is expected to be protected if the risks to these maximally exposed farmers are within acceptable levels. However, to determine potential average risks to residents within the study area, residential risks are also evaluated at a hypothetical location representative of average exposure concentrations across the study area. While the maximum impact farmer and residents did not include the use of surface water as a drinking water source (because the Borough of Bath water supply is derived from groundwater), the drinking surface water pathway was included in the average case resident's exposure.

In addition to incorporating conservative exposure factors into the risk assessment, the methods used to assess the quantity of emissions, the modeling of their distribution in the environment, their movement into the food chain, and their ultimate toxicity were all assessed in a highly conservative manner. As previously discussed, these conservative assumptions were made in the risk assessment to ensure that data gaps in the exposure characterization and the toxicological assessment did not lead to an underestimation of actual estimates of human health risk (i.e., to err on the side of protecting public health). Thus, the risk assessment is designed to provide a conservative analysis intended to indicate the upper range of the potential for health risks to be present. As a result, the final estimates presented in this assessment overestimate exposures and risks, and in fact, are likely to be near or higher than the upper end of the range of exposures and risks experienced by any individual within a subpopulation for each exposure pathway.

Risk Assessment Methodology

Health risk assessment was developed by regulatory agencies, national and international scientific advisory bodies, and independent research scientists as an method for assisting in decision making where human health is concerned. In order to ensure that risk assessments are protective of human health and the environment, various agencies have developed guidelines for the performance of risk assessments. This risk assessment was conducted to quantitatively estimate potential risks to human health and qualitatively evaluate potential impacts to ecological receptors. The assessment was conducted with reference to regulatory guidelines, using conservative (health protective) assumptions. The methodology relied first and foremost on PADEP's Guidelines, which provide detailed information concerning the exposure scenarios and exposure pathways to be evaluated, as well as default exposure factors and methods to be assumed in conducting the analysis. However, to evaluate all of the potential public health concerns outlined above and to perform analyses using the best available methods and data, additional sources were relied upon and approved by PADEP in performing the risk assessment. These additional sources included:

- California Air Pollution Control Officer's Association's (CAPCOA) "*Air Toxics "Hot Spots" Program: Revised 1992 Risk Assessment Guidelines*" (CAPCOA, 1993)
- EPA's *Exposure Assessment Guidance for RCRA Hazardous Waste Combustion Facilities* (EPA, 1994a),
- EPA's "*Methodology for Assessing Health Risks Associated with Indirect Exposure to Combustor Emissions*" (EPA, 1990), as well as the 1993 addendum (EPA, 1993a) to this document,
- EPA's "*Estimating Exposure to Dioxin-Like Compounds*" (EPA, 1994b), in conjunction with the Agency's dioxin toxicity equivalence factor (TEF) approach (EPA, 1989),
- EPA's *"Great Lakes Water Quality Initiative Technical Support Document for the Procedure to Determine Bioaccumulation Factors"* (EPA 1995c),
- Methodologies and approaches incorporated into the draft multipathway risk assessment conducted for the WTI hazardous waste incinerator (EPA, 1995d),
- The ecological assessment is conducted in accordance with the criteria set forth in 25 PA Code Section 269.50 (State of Pennsylvania, 1990), and
- EPA's *Proposed Guidelines for Ecological Risk Assessment* (EPA, 1996a).

Other EPA risk assessment guidance documents were also relied upon, as well as available site-specific information. In all cases, the source of information used to characterize each parameter in the risk assessment is fully referenced.

In performing the risk assessment for each of the chronic and acute scenarios and subpopulations of concern, the critical components of the analysis may be summarized as follows:

- The characterization of long-term average and short-term maximum emission rates associated with the kiln stacks and HWDF storage areas, and short-term maximum emission rates associated with each of the hypothetical accident scenarios;
- Modeling the air dispersion of short-term maximum and long-term average emissions released during each of the acute and chronic scenarios, and the deposition of long-term average stack emissions onto surrounding soils, produce, vegetation, and surface waters;
- The incorporation of the deposited stack emissions into soil, plant root zones, produce, feed, cattle, milk, poultry, surface water (via eroded soils as well as deposition), and fish;
- The frequency and duration of exposure to the emissions incorporated into all these various media for individuals within each subpopulation of concern; and,
- The potential acute and chronic inhalation toxicity associated with the chemicals emitted under each of the acute and chronic scenarios, and the chronic oral toxicity of emitted chemicals that accumulate in media other than air.

The methods used to perform each of these critical analyses, and the basis of the determinations are summarized below:

<u>Chemicals and their emission rates from facility stacks</u>: As agreed to by PADEP, the stack emission rates incorporated into the risk assessment relied primarily on the results of Keystone's 1996 PADEP annual compliance stack test. During this test a pre-defined and comprehensive list of metals, dioxins/furans, PCBs, semi-volatile and volatile organic compounds were identified as chemicals of potential concern (COPCs) and analyzed for in both kiln stacks. In addition, semi-volatile and volatile tentatively identified compounds (TICs) detected during the testing event were also reported. The results of the 1996 compliance test were supplemented by the results of the 1995 BIF recertification test. Both testing events were conducted following PADEP-

approved protocols, at an HWDF feed rate equal to approximately 75% of the total heat input of each kiln. The highest emission rate recorded for each COPC during either of these two tests was used to characterize emissions under maximum normal operating conditions. While many of the COPCs were not detected in any of the stack test analyses for either kiln, they were carried forward into the risk assessment (at one-half of the maximum recorded detection limit) if either: 1) a reasonable detection limit was not achieved during the testing, or 2) the detection limit was associated with greater than a $1x10^{-8}$ inhalation risk at the maximum offsite impact point. The resulting emission rates were used in the assessment of potential acute effects associated with maximum short-term emissions under normal operating conditions. However, for the acute upset event scenario, the short-term maximum normal emission rates were scaled up to account for the worst-case number and duration of pollution control equipment failures that could be expected to occur during any one hour. Similarly, for chronic plausible maximum scenario, the normal emission rates were scaled up to account for the worst-case number and duration of pollution control equipment failures that, based on historical operating data, could be expected to occur over the course of a year.

Chemicals and their emission rates from fugitive and accidental releases: The list of chemicals that might be released via fugitive emissions or accidental releases were based on the results of organic chemical analyses performed on composite liquid HWDF samples collected at the Keystone facility during 1995 and 1996. Emphasis was on the organic volatile and semi-volatile constituents of liquid HWDF, since metals and less volatile organic constituents of liquid HWDF vaporize poorly, and solid HWDF is less likely to vaporize or be involved in accidental releases to the environment. Therefore, the greatest potential for risks are associated with the handling and storage of liquid HWDF. The waste derived fuel composition was primarily identified based on a composite liquid HWDF sample collected during the third quarter of 1996 by the Keystone facility. The composite sample was comprised of samples taken from each of the HWDF tank truck loads received at the facility during this time period. This data source was supplemented by data obtained in screening analytical tests performed on composite samples collected at the Keystone facility throughout 1995. These primary and secondary data sources were used to identify the waste derived fuel composition for incorporation into the modeling of both fugitive emissions and emissions associated with the hypothetical storage tank and tank truck accident and spill scenarios. To characterize the potential impacts of the hypothetical storage tank rupture and fire scenario, the formation and release of acutely toxic products of combustion were evaluated.

The fugitive emission rates were developed based on the HWDF composition using emission factors developed by EPA for process equipment. The emission rates used to characterize waste derived fuel constituents in the storage tank and tank truck spill scenarios and products of combustion for the storage tank fire scenario were developed within the accident scenario models selected for use. The volume of HWDF assumed to be released in the storage tank spill and fire scenarios was conservatively based on the capacity of the largest storage tank at the Keystone facility (31,500 gallons). By contrast, the volume of HWDF fuel assumed to be released during the hypothetical tank truck accident (630 gallons) was based on U.S. Department of Transportation statistics on spill volumes associated with tank truck accidents.

<u>Modeling the air dispersion and deposition of facility stack and fugitive releases</u>: The EPA Industrial Source Complex Short-Term 3 (ISCST3) air dispersion model was used to calculate both annual average and one-hour maximum ambient air concentrations associated with both stack and fugitive emissions, and annual average deposition amounts associated with the bioaccumulatable components of stack emissions. ISCST3 is EPA's preferred model for evaluating the dispersion of emissions from complex industrial sources due to its versatility, accuracy and the fact that it tends to yield conservative results. Stack parameters for input into the model were obtained from past compliance tests at the Keystone facility and five years of meteorological data collected at the nearby Lehigh Valley International Airport were obtained from the National Weather Service (NWS) station. All other parameters were based on the conservative default parameter options within ISCST3 or conformed to EPA guidance. In estimating ambient air concentrations, the ISCST3 modeling analysis also incorporated the conservative assumption that there are no removal mechanisms, including deposition, from the plume prior to inhalation. Separate modeling runs were performed to determine the annual average deposition rates of bioaccumulatable stack chemicals used in calculating concentrations in soil, vegetation, cattle, milk (and milk products), poultry, surface water, eggs, and fish.

<u>Modeling the accident scenarios</u>: Based on PADEP's Guidelines, input from the PADEP technical representatives, and potential scenarios outlined in EPA's *Offsite*

Consequence Analysis Guidance (EPA, 1996b), three accident scenarios were identified for analysis in this assessment, as summarized below:

- HWDF Storage Tank Spill: The largest capacity HWDF storage tank was assumed to rupture and spill its entire contents into the surrounding secondary containment system. Uncontrolled volatile emissions from the containment area were then assumed to occur for at least one hour;
- HWDF Storage Tank Fire: The largest capacity HWDF storage tank was assumed to rupture and spill its entire contents into the secondary containment system. Further, an ignition source was assumed to be present and it was conservatively assumed that complete uncontrolled combustion of the released HWDF would occur within one hour; and
- HWDF Tank Truck Spill: A 630 gallon spill was assumed to occur from a tank truck unloading HWDF within the facility's unloading area. Based on U.S. Department of Transportation statistics, the assumed spill volume is equivalent to an upperbound releasing tank truck accident. Uncontrolled volatile emissions were then assumed to occur for a time period of at least one hour.

These scenarios are considered to be reflective of worst-case hypothetical accident scenarios that could potentially be associated with the storage and transfer of HWDF at the Keystone facility. The hypothetical accident scenarios are considered to be worst-case due to both the low probability of the release events actually occurring and the fact that Keystone's inplace mitigation equipment and Preparedness, Prevention and Contingency Plan (PPC Plan) would likely result in the effective control of potential emissions within a very short time duration.

The air dispersion models used to estimate potential ambient air impacts associated with the hypothetical storage tank and tank truck spills are the Areal Locations of Hazardous Atmospheres (ALOHA) (version 5.2.1) (EPA, 1995e) and the SAFER system TRACE model (version 8.0a) (Safer Systems, 1997). The overall modeling approach and methodology to assess the accidental release scenario followed recommendations contained in the *EPA Guidance on the Application of Refined Dispersion Models to Hazardous/Toxic Air Pollutant Releases* (EPA, 1993b), as well as knowledge and experience gained in the performance of other similar accidental release modeling studies. To make dispersion calculations, both ALOHA and TRACE make a distinction between neutrally buoyant gases, which are about as buoyant as air, and heavy gases, which form vapor clouds that are heavier and denser than air. The values used to characterize meteorological and other input parameters were selected so as to estimate short-term maximum offsite air concentrations under conservative dispersion conditions.

Ambient air concentrations of products of combustion for the hypothetical storage tank fire scenario are related to emission rates and meteorological conditions affecting chemical formation and dispersion. To predict both the products of combustion from the fire as well as their dispersion downwind of the fire, the Hot Spills model (Trinity, 1994) was used. In performing the modeling, the conservative assumption was made that complete uncontrolled combustion of all released HWDF occurs in one hour following the release. In addition, worst-case dispersion conditions (wind speed and stability category) were assumed for all model runs.

<u>Transfer of the dispersed and deposited releases into soil, vegetation, cattle, milk, poultry, surface water (via eroded soils as well as deposition), fish, and mother's milk</u>: Over 150 organic chemicals were evaluated in the risk assessment for the direct exposure route; i.e., inhalation. However, the list was reduced for the evaluation of indirect exposure pathways (e.g. ingestion of homegrown fruits and vegetables, ingestion of cattle meats, etc.). This list was reduced to focus the indirect pathway risk assessment on those chemicals emitted from the Keystone facility with the greatest potential to move through the food chain and be associated with risk via indirect routes of exposure (i.e., ingestion and dermal contact). The method used to identify the organic chemicals of concern via indirect exposure pathways was identical to that developed by EPA for other sites (EPA, 1995d). Consistent with EPA's approach, all metals were also carried forward into the indirect exposure analysis.

The calculations of exposure via indirect pathways started with the development of plausible maximum long-term soil concentrations. To derive chemical-specific soil concentrations, the annual average deposition rate of chemicals (as calculated using EPA's ISCST3 model) was assumed to be incorporated into study area soils for 35 years, depleting only through leaching, volatilization, and degradation. After 35 years of accumulation, these concentrations were then assumed to erode during rainfall events into surrounding surface waters. The erosion model used to determine chemical-specific concentrations within different compartments of the surface water bodies was based on a conservative steady-state model developed by EPA (1994b). However, the effects of erosion conservatively were not assumed to deplete soil concentrations, such that implausibly high exposure concentrations were assumed throughout the entire exposure period which, in some cases, was 70 years. Surface waters were also assumed to be impacted by air deposition.

Vegetation, animal meats and dairy product concentrations were predicted using methodologies recommended in PADEP's Guidelines. The vegetation concentrations were developed based on root uptake from the conservatively derived soil concentrations. Direct deposition onto plant surfaces was also assumed in the derivation of plant concentrations. The animal products were predicted assuming the animals were raised on feed (vegetation) grown entirely in soils at the maximally impacted farm location. The surface water concentrations which, as previously discussed, were estimated using a conservative steady-state model (EPA, 1994b) were combined with EPA's current methods (EPA, 1995d) to predict fish tissue concentrations.

Finally, the model used to predict the concentrations in breast milk followed the approach defined in PADEP's Guidelines. It should be noted that for breast milk and for most of the chemicals inadvertently ingested by the cattle and poultry, metabolism is assumed to be zero, i.e. the body is assumed to be incapable of converting it into a chemical form that would easily be eliminated, even though it is likely that many of these substances would have some metabolic elimination. Under the breast-milk exposure pathway, the highly conservative assumption is made that post-infancy, the individual lives 44 (upperbound resident and farmers), 30 (high-end resident) or 40 (high-end farmer) more years as an adult at the same receptor location.

<u>The frequency and duration of the population exposure to the various media in which emissions may be incorporated</u>: The fate and transport models presented above were used to estimate the environmental media concentrations of substances released from the Keystone facility stacks and fugitives using conservative assumptions. With respect to the acute exposure scenarios, e.g. accident scenarios and short-term health impacts, the environmental concentrations were compared directly to acute toxicity criteria (ATCs) that were also concentration based. Therefore, frequency and duration of exposures as well as intake rates; e.g., ingestion rates, are relevant only to the chronic exposure case whereby the magnitude of the exposure was used to ascertain an estimate of chemical-specific doses for each exposure pathway.

The frequency and duration of contact with contaminated media and the intake rates were estimated for the residential and farming population, based on assumptions about behavior, e.g. activity patterns. Nationwide surveys are available to characterize the general variability in human behavior patterns. The conservative assumptions that were made in the application of these data assume these individuals were exposed at the frequency, duration, and intake rates represented by the 95th percentile of the population. Thus, in adding the exposure pathways, it was assumed that the individual who ingests the 95th percentile (near maximum) amount of fruits and vegetables was also the individual who ingests the 95th percentile (near maximum) amount of fish, beef, milk and milk products, etc. Similarly, the ingested fraction that is homegrown or locally raised (at the nearby most impacted farm) was also conservatively assumed to be large.

To illustrate the different exposure scenarios, Table ES-1 has been constructed to provide the year round ingestion rates related to the indirect pathways. These ingestion rates are shown only for the locally grown or raised fractions and were converted from those listed in the body of the report to ounces rather than grams. It was further assumed that 4 ounces represents a serving size. Thus, Table ES-1 provides the servings of each food group potentially containing constituents associated with facility air emissions. This table demonstrates some of the assumed differences between the residents and farmers. For example, it was assumed that while the upperbound and high-end residents ate 3.4 and 2.4 servings per week, respectively, of locally raised beef, the upperbound and high-end farmers ate 8.5 and 6.1 servings, respectively, of meat from cattle raised at the maximally impacted farm location. Similarly, it was assumed that the upperbound resident ate 4.9 servings of homegrown vine vegetables per week (throughout the year), while the upperbound adult farmer ate 9.2 servings per week.

<u>The potential toxicity, characterized by the acute and chronic risks, associated with the emitted chemicals at the levels to which the population is exposed</u>: In the majority of risk assessments, as in this risk assessment, available scientific information is insufficient to provide a complete understanding of all the toxic properties of chemicals to which humans are potentially exposed. It is generally necessary, therefore, to infer these properties by extrapolating them from data obtained under other conditions of exposure, which frequently involve the use of laboratory animals. With respect to the acute scenarios, the ATCs were developed to be in compliance with PADEP's Guidelines. In developing the ATCs, modifying factors are sometimes added to the

evaluation, which further reduce the ATC to below the concentration at which the toxicity is to be expected within the general population so as to be protective of public health; e.g., sensitive members of the population.

With respect to the chronic risks that are associated with chronic low-level exposures, EPA's toxicity assessment served as the basis of the assessment. EPA's methods compensates for uncertainties related to study quality, use of laboratory animals, sensitive species, etc., through the use of uncertainty factors and modifying factors when deriving values for noncarcinogens and through the use of the upper 95% confidence limit when deriving the values for carcinogens. In this manner, the level at which a chemical is shown to cause either no effect or a low level effect is further reduced to add conservatism to the evaluation of public health risks.

Additional conservatism is incorporated in the actual models used to derive the toxicity values. For example, EPA has historically relied upon the non-threshold method for developing carcinogenic toxicity values. This non-threshold method assumes there is carcinogenicity associated with all exposure levels. However, in EPA's most recent proposed guidance, the Agency has begun to recognize that this may not be justified for all chemicals. EPA proposes to rely on the use of nonlinear threshold models where warranted. Nonetheless, EPA's current reliance on conservative models ensures that the toxicity values so derived are very unlikely to underestimate the true toxicity of a chemical.

To further assure that risks were not understated, this risk assessment developed surrogate chronic inhalation toxicity values for chemicals which have no known toxicity or insufficient toxicity information. The surrogate values were assigned by developing an emission weighted toxicity value of the chemicals in each chemical class, e.g. volatiles, whose toxicities were known, and assigning the surrogate values to the chemicals without toxicity data.

Finally, in developing the chronic risks, the risks are summed for each chemical for each pathway, independent of the target organ, e.g., liver or kidney, affected by the chemical. Thus, despite the fact that one chemical may increase the risk associated with lung cancer and another with liver cancer, the risks are nonetheless summed as if both chemicals acted together to induce a greater risk to any one organ. Since the aggregate risks are below levels of concern, no further effort was made to separate risk according to target organ. This total aggregation of risk is a conservative approach biased toward protecting public health.

Ecological Assessment

Various critical habitats, as defined in PA Code § 269.50 (State of Pennsylvania, 1990), were identified during the assessment process. No critical habitats meeting the criteria under PA Code § 269.50 were found. The most significant habitat that could potentially be adversely affected by site-related air emissions was identified as the Monocacy Creek. Potential impacts to the aquatic receptors associated with long-term chronic emissions were determined to be of greatest potential concern.

To evaluate the effect of long-term chronic emissions, the surface water concentrations (dissolved and suspended sediment concentrations) associated with chronic deposition of air emissions were estimated using fate and transport models. In the model, surface water concentrations were estimated based on both direct deposition of emissions and erosion of impacted watershed soils into the water body. The erosional component of this analysis conservatively assumed that chemical concentrations accumulated in watershed soils after 35 year of deposition were eroded into the surface water body. The resulting modeled surface water concentrations were compared to chronic aquatic water quality criteria for the protection of aquatic life and found not to exceed these criteria. Hence, long-term chronic impacts to the aquatic ecosystem within Monocacy Creek are unlikely to occur as a result of the air emissions.

Summary of Results

The purpose of a risk assessment is to determine the likelihood that an event will occur and the magnitude of its consequences, so that public policy decisions can be made. In the regulatory arena, the important factors that determine the acceptability of a risk are the probability of an occurrence and the perceived severity of that occurrence.

In this risk assessment, potential acute effects were evaluated for stack and fugitive emissions under both normal maximum operating conditions and upset conditions associated with the failure of air pollution control equipment. In addition, potential acute effects were evaluated for three low probability/high exposure potential hypothetical accident scenarios. In all cases, the maximum short-term (i.e., one-hour average) ambient air concentrations were predicted to be below levels of potential health concern for sensitive receptors; i.e., the ATCs developed under PADEP guidance, which relied upon values developed by EPA, FEMA, NIOSH, AIHA, and ACGIH. Hence, the focus of the remaining discussion will be on the evaluation of the potential chronic human health effects associated with air emissions from the facility.

Carcinogenic risks are presented in scientific notation; e.g. a risk of $1x10^{-5}$. This risk implies a 1 in 100,000 probability of an individual developing cancer over the course of his/her lifetime due to facility-related emissions. PADEP has chosen to use an excess lifetime risk of $1x10^{-5}$ (1 in 100,000) as a target level of risk. To put this target risk level in context, it should be noted that the incidence of cancer in the United States from all sources is approximately 50,000 per 100,000 (50%) for males and 33,000 per 100,000 (33%) for females (ACS, 1997).

Table ES-2 presents the upperbound and high-end excess lifetime cancer risk estimates for the maximally impacted resident, (adult and child), the study area average resident (adult and child) and the maximally impacted farm family (adult and child) associated with exposure to both stack and fugitive emissions. In addition, upperbound and high-end excess lifetime cancer risk estimates are also provided for breast-fed infants assumed to live at each of these receptor locations. As shown in Table ES-2, the upperbound breast-fed infant risk estimates predominate because, in accordance with PADEP's Guidelines, it is conservatively assumed that post-infancy, the individual lives for a further 44 years (as an adult) at the same location. Similarly, under the high-end exposure scenario, resident infants are assumed to live at the same location for an additional 30 years post-infancy (as an adult), and infants of farm families are assumed to live at the same location for an additional 40 years post-infancy (as an adult). The range of total cancer risks associated with exposure to both plausible maximum annual average stack and fugitive emissions, for all plausible routes of exposure, are summarized below:

- Adult Farmer: From $2.0x10^{-6}$ (2.0 in 1 million) for the high-end farmer to $4.0x10^{-6}$ (4 in 1 million) for the upperbound farmer.
- Adult Resident: From $7.2x10^{-7}$ (7.2 in 10 million) for the high-end study area average resident to $4.7x10^{-6}$ (4.7 in 1 million) for the upperbound maximally impacted resident.

- Children: From $5.0x10^{-7}$ (5.0 in 10 million) for the high-end child of study area resident to $1.6x10^{-6}$ (1.6 in 1 million) for the high-end child of maximally impacted resident.
- Breast fed Infant: From $1.6x10^{-6}$ (1.6 in 1 million) for breast fed infants of high-end exposure study area average residents (who then live as study area average residents for 30 years post-infancy) to $4.9x10^{-6}$ (4.9 in 1 million) for breast fed infants of both upperbound maximally exposed residents and farmers (who then live as maximally exposed resident and farmers for 44 years post-infancy).

Besides ingestion of mother's milk as an infant, residential carcinogenic risks in this assessment are primarily driven by inhalation and ingestion of locally produced dairy products for maximally exposed residents. By contrast, cancer risks to farm families are primarily driven by ingestion of beef and dairy products. Risks associated with the ingestion of homegrown fruits and vegetables and fish also contribute to the total risk to both resident and farm receptors. Finally, it should be noted that the risk estimates provided above are unlikely to underestimate actual risks because, in accordance with PADEP's Guidelines, conservative emission estimates, fate and transport models, exposure factors, and toxicity factors were incorporated into the analysis. Consequently, the upperbound risk estimates are very likely to "... be substantially greater than the actual risk expected from operation of the hazardous burning unit." (PADER, 1993).

The assessment of noncarcinogenic risks associated with plausible maximum chronic stack and fugitive emissions are evaluated through the use of a hazard index. The hazard index for a chemical is the ratio of the sum of the average daily dose of that chemical for all pathways to the toxicity reference dose for the chemical. Because the toxicity reference dose is established at a no effect level (also incorporating safety and uncertainty factors), values of the hazard index that are less than one indicate that effects are unlikely. However, in evaluating noncarcinogenic risks, PADEP has chosen to use a hazard index of 0.25, or 1.0 after accounting for all background sources, as the target level.

In Table ES-3, total non-cancer risks to individuals within each subpopulation of concern with respect to potential exposure to both stack and fugitive emissions were calculated in a similar manner as performed for carcinogens. In these tables, the non-cancer risks were obtained by summing all hazard indices for all chemicals combined for all pathways independent of the target organ; i.e., the organ which is effected by the toxicant. Ignoring target organ effects results in a very conservative analysis, since it ignores the fact that chemicals acting on different target organs do not combine to have a summed effect on one organ.

The range of summed hazard indices associated with exposure to both plausible maximum annual average stack and fugitive emissions, for all plausible routes of exposure, are summarized below:

- Adult Farmer: 0.12 for both high-end and upperbound farmers.
- Adult Resident: From 0.11 for the high-end study area average adult resident to 0.20 for the upperbound maximally impacted adult resident.
- Children: From 0.04 for the high-end study area average child to 0.18 for the high-end maximally impacted resident child.

As summarized above, none of the hazard indices are above 0.25, the target level chosen by PADEP. From Table ES-3, the ingestion of homegrown fruits and vegetables and air inhalation exposure pathways drive risks for residents. By contrast, the ingestion of homegrown fruit and vegetable pathway drives risk for farm families. Also, for both adult residents and farmers, the ingestion of recreationally caught fish from Monocacy Creek also contributes noticeably to risk. Similar to the assessment of chronic cancer risks, these non-cancer risks are unlikely to have been underestimated because, in accordance with PADEP's Guidelines, conservative emission estimates, fate and transport models, exposure factors, and toxicity factors were incorporated into the analysis. Consequently, the upperbound and high-end non-cancer risk estimates are highly unlikely to underestimate risk to any individual within the surrounding community.

Risk Assessment Findings

The multipathway risk assessment was conducted following a PADEP approved protocol and evaluated several chronic and acute scenarios associated with HWDF-related process emissions (i.e., stack and fugitive) from the Keystone facility. Also included were potential risks associated with several hypothetical low probability/high impact HWDF-related accident scenarios. In performing these analyses, assumptions were required to characterize input parameters for the emissions estimation, the fate and transport modeling of emissions in the environment, the exposure assessment, the toxicity assessment, and the characterization of risk. These assumptions were consistently made so as to bias the analysis in favor of protecting public health. The net result is that the predicted risks are highly unlikely to underestimate the true risks to any member of the surrounding community. Indeed, the upperbound risks, which were calculated in accordance with PADEP's Guidelines, "... would very likely be substantially greater than the actual risk expected from the operation of the hazardous burning unit." (PADER, 1993). Nonetheless, even with the consistent incorporation of conservative assumptions, the chronic and acute risks predicted for each scenario evaluated in this assessment are lower than those deemed acceptable by government agencies, meaning that potential impacts to public health and the environment are regarded as inconsequential.

Table ES-1

Ingestion Rates of Locally Grown and Raised Fruits, Vegetables and Animal Products

Ingestion Pathway	Ingestion Rates in Servings per Week[a]	Exposed Individual					
		Upper Bound Residential Adult	High-End Residential Adult[b]	High-End Residential Child[b]	Upper Bound Farmer Adult	High-End Farmer Adult[b]	High-End Farmer Child[b]
Cattle Meat	Local	3.4	2.4	2.0	8.5	6.1	5.1
Eggs	Local	0.9	0.6	1.0	2.1	1.5	2.4
Poultry	Local	0.0	0.0	0.0	2.0	1.4	1.6
Milk/Milk Product	Local	13.2	12.7	20.1	13.8	13.2	20.9
Leafy Vegetables	Local	2.5	2.3	0.6	4.6	4.4	1.2
Root Vegetables	Local	4.9	4.7	1.9	9.2	8.8	3.5
Vine Vegetables	Local	4.9	4.7	2.4	9.2	8.8	4.4
Fruit	Local	2.6	2.5	6.8	6.4	6.2	17.1
Fish	Local	1.0	0.9	NA	1.0	0.9	NA

[a]Assumes 4 oz/serving size

[b]Adjusted to 350 days exposure as opposed to 365 days of exposure

Table ES-2

Summary of Pathway Specific and Total Excess Lifetime Cancer Risks for Receptors of Concern

Receptor	Inhalation	Ingestion of Soil	Dermal Contact with Soil	Dermal Contact and Incidental Ingestion of Surface Water While Swimming	Ingestion of Drinking Water	Ingestion of Homegrown Fruits and Vegetables	Ingestion of Cattle Meat	Ingestion of Cattle Milk	Ingestion of Poultry	Ingestion of Eggs	Ingestion of Recreationally Caught Fish	Ingestion of Mother's Milk as Infant	Total Excess Lifetime Cancer Risks
MEI Upperbound Adult Resident	1.67E-06	2.47E-08	1.03E-07	1.26E-08	-	3.84E-07	5.46E-07	1.31E-06	-	2.73E-09	6.73E-07	-	4.73E-06
MEI High-End Adult Resident	6.87E-07	1.02E-08	4.23E-08	5.42E-09	-	1.58E-07	1.68E-07	5.39E-07	-	8.50E-10	2.77E-07	-	1.89E-06
MEI High-End Child Resident	5.13E-07	1.90E-08	2.07E-08	2.08E-09	-	1.30E-07	1.31E-07	7.97E-07	-	1.24E-09	-	-	1.61E-06
Study Area Average Upperbound Adult Resident	1.93E-07	4.36E-09	1.63E-08	1.26E-08	1.22E-08	8.54E-08	2.31E-07	5.68E-07	-	1.22E-09	6.73E-07	-	1.80E-06
Study Area Average High-End Adult Resident	7.93E-08	1.79E-09	6.68E-09	5.42E-09	5.02E-09	3.51E-08	7.11E-08	2.33E-07	-	3.79E-10	2.77E-07	-	7.15E-07
Study Area Average High-End Child Resident	5.92E-08	3.34E-09	3.27E-09	2.08E-09	2.34E-09	2.88E-08	5.53E-08	3.45E-07	-	5.53E-10	-	-	5.00E-07
Upperbound Adult Farmer	3.01E-07	8.75E-09	3.76E-08	1.26E-08	-	2.27E-07	1.37E-06	1.37E-06	6.09E-09	6.40E-09	6.73E-07	-	4.01E-06
High-End Adult Farmer	1.65E-07	1.39E-08	2.06E-08	7.23E-09	-	1.24E-07	5.61E-07	7.49E-07	2.51E-09	2.66E-09	3.69E-07	-	2.02E-06
High-End Child Farmer	9.23E-08	6.71E-09	7.55E-09	2.08E-09	-	8.74E-08	3.28E-07	8.30E-07	1.94E-09	2.91E-09	-	-	1.36E-06

Table ES-2

Summary of Pathway Specific and Total Excess Lifetime Cancer Risks for Receptors of Concern

Receptor	Inhalation	Ingestion of Soil	Dermal Contact with Soil	Dermal Contact and Incidental Ingestion of Surface Water While Swimming	Ingestion of Drinking Water	Ingestion of Homegrown Fruits and Vegetables	Ingestion of Cattle Meat	Ingestion of Cattle Milk	Ingestion of Poultry	Ingestion of Eggs	Ingestion of Recreationally Caught Fish	Ingestion of Mother's Milk as Infant	Total Excess Lifetime Cancer Risks
Breast-fed Infant to Adult - MEI Upperbound Resident	1.05E-06	1.55E-08	6.48E-08	7.95E-09	-	2.42E-07	3.43E-07	8.25E-07	-	1.72E-09	4.23E-07	1.89E-06	4.86E-06
Breast-fed Infant to Adult - MEI High-End Resident	6.87E-07	1.02E-08	4.23E-08	5.42E-09	-	1.58E-07	1.68E-07	5.39E-07	-	8.50E-10	2.77E-07	1.73E-06	3.61E-06
Breast-fed Infant to Adult - Study Area Average Upperbound Resident	1.21E-07	2.74E-09	1.02E-08	7.95E-09	9.85E-07	5.37E-08	1.45E-07	3.57E-07	-	7.65E-10	4.23E-07	7.67E-09	2.11E-06
Breast-fed Infant to Adult - Study Area Average High-End Resident	7.93E-08	1.79E-09	6.68E-09	5.42E-09	9.09E-07	3.51E-08	7.11E-08	2.33E-07	-	3.79E-10	2.77E-07	5.02E-09	1.62E-06
Breast-fed Infant to Adult - Upperbound Farmer	1.89E-07	5.50E-09	2.36E-08	7.95E-09	-	1.43E-07	8.59E-07	8.59E-07	3.83E-09	4.02E-09	4.23E-07	2.34E-06	4.86E-06
Breast-fed Infant to Adult - High-End Farmer	1.65E-07	1.39E-08	2.06E-08	7.23E-09	-	1.24E-07	5.61E-07	7.49E-07	2.51E-09	2.66E-09	3.69E-07	2.04E-06	4.06E-06

- = Not applicable for this receptor.

Table ES-3

Summary of Pathway Specific and Total Noncarcinogenic Risks for Receptors of Concern

Receptor	Inhalation	Ingestion of Soil	Dermal Contact with Soil	Dermal Contact and Incidental Ingestion of Surface Water While Swimming	Ingestion of Drinking Water	Ingestion of Homegrown Fruits and Vegetables	Ingestion of Cattle Meat	Ingestion of Cattle Milk	Ingestion of Poultry	Ingestion of Eggs	Ingestion of Recreationally Caught Fish	Ingestion of Mother's Milk as Infant	Total Noncancer Risks
MEI Upperbound Adult Resident	7.50E-02	3.60E-04	4.24E-04	4.39E-05	-	2.30E-02	1.09E-03	8.85E-04	-	4.47E-06	9.71E-02	-	1.98E-01
MEI High-End Adult Resident	7.50E-02	3.45E-04	4.07E-04	4.39E-05	-	2.21E-02	7.86E-04	8.48E-04	-	3.25E-06	9.31E-02	-	1.93E-01
MEI High-End Child Resident	7.50E-02	3.22E-03	9.95E-04	1.65E-04	-	8.84E-02	3.06E-03	6.27E-03	-	2.37E-05	-	-	1.77E-01
Study Area Average Upperbound Adult Resident	4.18E-03	1.15E-04	1.36E-04	4.39E-05	1.29E-03	5.58E-03	1.20E-03	9.15E-04	-	5.28E-06	9.71E-02	-	1.11E-01
Study Area Average High-End Adult Resident	4.18E-03	1.10E-04	1.30E-04	4.39E-05	1.24E-03	5.35E-03	8.61E-04	8.77E-04	-	3.84E-06	9.31E-02	-	1.06E-01
Study Area Average High-End Child Resident	4.18E-03	1.03E-03	3.18E-04	1.65E-04	2.89E-03	2.12E-02	3.35E-03	6.48E-03	-	2.80E-05	-	-	3.97E-02
Upperbound Adult Farmer	6.91E-03	9.70E-05	1.15E-04	4.39E-05	-	1.31E-02	2.73E-03	9.22E-04	4.01E-05	1.05E-05	9.71E-02	-	1.21E-01
High-End Adult Farmer	6.91E-03	2.70E-04	1.10E-04	4.39E-05	-	1.26E-02	1.97E-03	8.84E-04	2.89E-05	7.62E-06	9.31E-02	-	1.16E-01
High-End Child Farmer	6.91E-03	8.69E-04	2.69E-04	1.65E-04	-	5.75E-02	7.65E-03	6.53E-03	1.49E-04	5.56E-05	-	-	8.01E-02

- = Not applicable for this receptor.

2.0 SITE CHARACTERIZATION

In this section, background information on the setting of the Keystone facility is provided. Initially, to define the potential impact of Keystone's HWDF-related activities on the local area, a general description of the plant's HWDF handling, storage, processing, and burning operations is provided. This discussion is followed by a description of the area surrounding the Keystone facility, along with land-use, water-use and demographic data pertinent to the risk assessment. Information on the facility and local area are provided in order to develop an understanding of viable scenarios and pathways through which exposure to Keystone-related chemical emissions could potentially occur, and to identify the location of potentially exposed populations of concern (e.g., residents, subsistence farmers, etc.). The information presented in this section is based on data retrieved during site visits, from the scientific literature, and from telephone conversations with individuals who have specialized knowledge about the area.

2.1 Facility Operations

Keystone's operations associated with the production of cement consist of two distinct components: 1) the production of clinker (the primary constituent of cement); and 2) the grinding of clinker into cement. Because the clinker grinding operations do not involve use of HWDF, this section is dedicated to describing operations associated with clinker production, and discusses both the process and the environmental controls.

2.1.1 Process Description

The Keystone facility operates two wet process cement kilns. The kilns operate under PADEP air quality construction and operating permits. Figure 2-1 provides a scale plot plan depicting the general layout of the Keystone facility and shows the location of the two wet process kilns and the exhaust stack for each kiln. A schematic of the process is presented in Figure 2-2.

The cement kilns are termed "rotary kilns" because the long cylindrical kilns (kiln 1 is 350 feet in length; kiln 2 is 540 feet in length) are constantly turning in order to mix the raw materials thoroughly and transport them down the kiln.

Fuel is fired at the clinker discharge end of the kilns. The kilns can burn a variety of fuels including coal, coke, fuel oil, natural gas, and non-hazardous and HWDF in pumpable form. The waste derived fuels may include various types of hazardous wastes suitable for substitution in the kilns to replace coal or other fossil fuels. A list of hazardous waste types, by code, that the facility may presently accept is included as Appendix A to this document. As shown in Figure 2-2, the liquid HWDF storage area currently consists of four aboveground storage tanks with a combined capacity of 93,000 gallons. PADEP has permitted the facility to construct additional aboveground tanks to increase liquid HWDF storage capacity by 180,000 gallons. PADEP has also permitted the facility to construct, within an onsite Solids Handling Building, a 300 cubic yard capacity bulk solid HWDF storage tank, and four bulk solid storage bins with a combined capacity of 600 cubic yards.

At the current time, HWDF is shipped to the site in single unit tanker trucks. While not currently utilized for this purpose, rail cars carrying HWDF can be received by Keystone. In order to comply with BIF regulations and their State permit, Keystone samples each load of HWDF prior to unloading and analyzes for BTU value, chlorine content, and the concentration of 10 BIF regulated metals. The measured values are compared against pre-determined permit limits to decide whether the waste is acceptable. If any of the contaminant levels exceed the acceptable level, the waste derived fuel is rejected. Accepted loads are pumped to one of the storage tanks described above. If in the future Keystone applies for and receives authorization to blend, the facility will mix fuels within onsite storage tanks to meet the conditions acceptable for firing in the kilns. Once a tank of HWDF is determined to be "kiln-ready", it is fired to one of the cement kilns and the feed rate monitored continuously and the values recorded. In addition, the feed rate and chloride content of the raw feed streams (cement slurry and coal) are also monitored. All of the data on feed stream contaminant levels and feed rates are entered into a computer tracking system to verify compliance with currently applicable permit limits.

2.1.2 Pollution Control Technology

The Keystone cement kilns have several types of pollution control technologies to ensure that minimal particulate and chemical releases occur to the environment. In addition, control devices are associated with each of the liquid and solid HWDF handling, storage and processing operations, to minimize losses of volatile organic compounds to the environment. This section discusses the most important pollution control methods associated with the HWDF-related operations.

2.1.2.1 Cement Kilns

The air pollution control equipment at each stack includes a multiple cyclone centrifugal collector followed by an electrostatic precipitator (ESP) that collects fine dust particles that are generated in the production process. The air pollution control equipment is designed to meet PADEP particulate matter emission limits. A portion of the dust that is captured in the control devices is recycled to the kilns for reintroduction into the process. The facility does not require acid gas controls due to the very alkaline environment in the kiln systems that minimize potential acid gas emissions.

In addition to the stack air pollution control systems, other important environmental controls are present. For example, thermal removal of organic compounds in the cement kiln results from the combustion conditions, which include long residence times, high temperatures, and turbulent mixing. Solid materials that enter the rotary kilns are heated for approximately 45 to 60 minutes, with the temperature of the material reaching at least 1,565°C (2,850°F). This exceeds EPA requirements for hazardous waste incineration facilities, which require residence times of no less than two seconds at 982°C (1,800°F).

Continuous monitoring of burning zone temperature, carbon monoxide, nitrogen oxides, opacity, and other parameters is also conducted for each kiln. Burning zone temperature is monitored to ensure optimal burning conditions in the kiln to facilitate thermal removal of organic chemicals. Carbon monoxide in flue gas is monitored to ensure adequate combustion is taking place; good combustion conditions exist when carbon monoxide emissions are minimized. In addition, a system of monitor interlocks is used to automatically shut off HWDF feed in the event that a monitored parameter exceeds any limit specified in the PADEP permits or by the BIF requirements.

2.1.2.2 Liquid HWDF Storage Tanks

As depicted in Figure 2-1, Keystone currently operates four liquid HWDF storage tanks at the facility: two 15,000 gallon capacity tanks and two 31,500 gallon capacity tanks.

The two 15,000 gallon tanks are constructed of carbon steel utilizing welded construction and API Standard 650. The tanks are labeled Tank IA and Tank IB. Each tank is 12 feet in diameter, 26 feet 2 inches in height, and supported by a concrete mat. The concrete mat is supported by a reinforced concrete floor. This concrete floor and surrounding walls form the secondary containment. The secondary containment area is coated with an epoxy coating to limit the infiltration of any spilled HWDF. The secondary containment system for tanks IA and IB composes a containment volume of 34,794 gallons. The required containment volume designed to store an accidental spill of 100% of the largest vessel or tank within the area plus the collected rainfall for a 25-year, 24-hour storm is 25,738 gallons. Each of the tanks is of fixed roof design and equipped with an explosion vent, conservation vent, and a top mounted agitator.

The two 31,500 gallon tanks are also constructed of carbon steel utilizing welded construction and API Standard 650. These tanks are labeled and identified as Tank 2 and Tank 3. Each tank is 14 feet in diameter and 36 feet, 3 inches high. Each tank is of fixed roof design and equipped with an explosion vent, conservation vent, and a top mounted agitator. Both tanks are supported by a reinforced concrete floor. The concrete floor and surrounding walls form the secondary containment area. The secondary containment system for Tanks 2 and 3 comprises a containment volume of 43,700 gallons. The required containment volume designed to store an accidental spill of 100% of the largest vessel or tank within the area plus the collected rainfall for a 25-year, 24-hour storm is 41,962 gallons. The secondary containment area is coated with an epoxy coating to limit the infiltration of any spilled HWDF.

All four existing HWDF storage tanks are monitored by an overfilling protection system composed of high level indicators, which signal an audible and visual alarm to the Control Room and unloading pad. Each of the HWDF storage tanks and the associated piping systems are subject to the RCRA 40 CFR 265 Subpart BB (EPA, 1997a) regulations. Consequently, they are required to have identification numbers, locations, and throughput material information, in addition to the leak detection and repair programs. In accordance with requirements of 40 CFR 264 Subpart CC (EPA, 1997b), all vapors from the four existing tanks are vented directly into kiln 2. In the event that kiln 2 is not in operation, the vapors are vented into kiln 1.

As previously discussed, the facility has been permitted by PADEP to construct additional liquid HWDF storage tanks at the facility. The new liquid HWDF tanks will be installed in containment areas located in the vicinity of the current storage tanks. Similar to the existing HWDF storage tanks, the planned tanks will be monitored by an overfilling protection system composed of high level indicators, which signal an audible and visual alarm to the Control Room and unloading pad. The planned tanks and the associated piping system also will be designed to satisfy the 40 CFR 264 Subpart BB and 40 CFR 264 Subpart CC requirements (EPA, 1997b,c). Similar to what occurs with the existing tanks, vapors from the planned tank will be routed directly into kiln 2, with kiln 1 as a back-up should kiln 2 not be operating. This satisfies the Subpart CC requirements.

2.1.2.3 Bulk Solid HWDF Storage Tank

The Keystone facility has been permitted by PADEP to construct a bulk solid fuel storage tank within a Solids Handling Building. The tank will be protected from precipitation and wind dispersal by the roof and walls of the building. The facility will be protected from run-on by the building foundation and the walls. The total storage capacity of the tank will be 300 cubic yards. Because only solids without free liquids are to be stored in the tank, secondary containment is not required by the regulations. A vent in the Solids Handling building will feed any vapors emanating from the bulk solid HWDF storage tank directly into kiln 2. In the event that kiln 2 is not in operation, the fugitive vapors will be routed to kiln 1.

2.1.2.4 Bulk Powder HWDF Tanks (Bins)

The facility has been permitted by PADEP to construct four bulk powder bins within the Solids Handling Building. Only solids that do not contain free liquids will be stored in these tanks. The planned bulk powder storage tanks will likely be subject to Subparts BB and CC of 40 CFR Part 264 (EPA, 1997b,c), due to the potential for volatile organic (VO) concentrations in the HWDF in exceedance of the Subpart CC exemption level. Therefore, the vents from the bulk tank dust collectors will be ducted to the combustion air inlet of kiln 2. In the event that kiln 2 is not in operation, any potential emissions will be routed to kiln 1.

2.2 Site Setting

The Keystone facility is located in Bath, East Allen Township, Northampton County, Pennsylvania, approximately 6 kilometers west of Nazareth, and 10 kilometers north of Bethlehem. In accordance with PADEP Guidelines, the study area within the risk assessment is defined as the area for which excess lifetime cancer risk via the inhalation route of exposure for all pollutants of concern is equal to or greater than $1x10^{-7}$. As defined in Section 3, this area was conservatively estimated to extend approximately 31 km to the east, 22 km to the south, 19 km to the west, and 19 km to the north (see Figure 3-1). However, for the purpose of defining the site setting, a general discussion of local and regional demographics within a distance of 20 km from the Keystone facility is presented. In addition, land-use patterns, a subsistence animal farm, and waterbody locations within 5 kilometers of the site are discussed in more detail, in order to identify receptors of primary concern. Figures 2-3 and 2-4 illustrate the facility's regional and local surroundings, respectively.

2.2.1 Local Demographics, Land Use, and Water Use

An examination of local demographic and land-use data for the area can identify the presence of sensitive subpopulations, and can provide information on the number of individuals that potentially may be exposed to emissions from the Keystone facility. As previously discussed, the study area, as defined under the risk-based criteria within the PADEP Guidelines, is developed in Section 3 of this risk assessment. However, for the purpose of this section, local and regional demographic data for the area within 20 km of the Keystone facility are presented, as well as detailed land- and water-use information for the area within 5 km of the facility. This area is delineated in Section 3 (see Figure 3-1).

2.2.1.1 Demographics

As shown in Figure 2-3, several communities are located within 20 km of the Keystone facility, including Nazareth, Bethlehem, Easton, and Allentown. Demographic information for these communities is presented in Table 2-1. This table shows population, income, and age distribution data for the 1990 U.S. Census, a 1994 update to the Census, and a 1999 forecast. Based on the 1990 data, the total population residing within 20 km of the study area is estimated to be 1,003,660. According to the 1994 update and 1999 forecast, it is anticipated that the population will increase in number and that the average per capita income also will increase. The age and income distributions of the population residing in the vicinity of the Keystone facility can be compared to the national and state average age and income distributions, as presented in Table 2-2 and Table 2-3, respectively. The population percentages within each category and the average per capita income for the local community are for the most part similar to those for the United States and the State of Pennsylvania.

2.2.1.2 Land Use

The land surrounding the Keystone facility consists of rolling hills in a primarily rural and agricultural setting, with an average elevation of about 200 meters above sea level. A map of the local land use patterns within 5 km of the Keystone facility is presented in Figure 2-4. Substantial industrial and commercial activity exists within the area. The closest residential areas are located just over 200 m to the east of the cement kiln stacks.

The activities of residents within the area influence the extent and magnitude to which they are exposed to chemicals emitted from the facility. Some residents cultivate backyard or community gardens. According to Mr. Greg Salt of the Northampton County Cooperative Extension Agency (1996), a wide variety of fruits and vegetables are grown in home gardens within the area.

According to Miss Jane Oswald of the Northampton County Farm Service Agency (1996), agricultural land located adjacent to the Keystone facility is used primarily for the growth of corn and soybean crops. These crops are used mainly as animal food supplies. Limited growth of oats, rye, and barley crops also occurs within the area.

The nearest subsistence animal farm is Maple Grove Farm, located over 2 km to the southeast of the Keystone facility. It is the only animal farm identified within 5 kilometers of the facility. Maple Grove is a dairy farm that also produces corn and soybean crops for animal feeding purposes. The farm's property boundary is depicted on Figure 2-4. Locations of sensitive human receptors within 5 km of the facility (i.e., schools, parks, nursing homes and hospitals) are also identified on Figure 2-4.

2.2.1.3 Local Water Use

In addition to local land use, Figure 2-4 depicts watersheds located within five kilometers of the Keystone facility. As shown on this figure, Monocacy Creek is the primary surface water body in close vicinity to the site. Based on information obtained from Mr. Terry Hanold of the Northampton County Waterway Conservation Office (1996), three reaches of the Monocacy Creek are stocked with trout from March to May of each year. The regular fishing season (8 fish/day limit) runs from April 13th through September 2nd. An extended season, with reduced take allowances (3 fish/day limit), runs from September 3rd to the beginning of March. No taking of fish is allowed from the beginning of March to the beginning of the fishing season (mid-April). According to Mr. Hanold, the Monocacy Creek is used exclusively for recreational fishing purposes.

Based on a site visit, the width of the branches of the Monocacy Creek (near the facility) varies from 3 feet to 10 feet or more and the depth varies from a few inches to up to several feet in certain locations. The west (main) branch typically has considerably greater flow than the east branch. According to local observers, the local population do not commonly use the Monocacy Creek for recreational swimming activities. According to information obtained from Mr. Greg Salt of the Northampton County Cooperative Extension Agency (1996), several surface water bodies in the area are used for recreational swimming purposes. These include Dutch Springs Quarry, Evergreen Lake, Minsi Lake, Prevaleros Lake, the Delaware River, the Lehigh River, and the Old Lehigh and Delaware Canal. The nearest of these surface water bodies is Dutch Spring Quarry, which is located just over 5 km to the southeast of the Keystone facility (see Figure 2-4). Evergreen Lake is situated approximately 7 km to the northeast of Bath, and the remaining water bodies are all located at greater distances from the Keystone facility.

The Borough of Bath, in which the Keystone facility lies, reports that two deep groundwater wells act as the sole source of potable water for the local community. Local surface water bodies that act as the primary supply of drinking water to local communities include the Lehigh River (Northampton), the Delaware River (Easton), the Little Lehigh Creek (Allentown), and Wild Creek Reservoir (Bethlehem). None of these surface water bodies are located within 5 km of the Keystone facility.

6.2 Evaluation of Potential Ecological Impacts

The most significant habitat that could potentially be adversely affected by site-related air emissions was identified as the Monocacy Creek. Potential impacts to the aquatic receptors may be associated with long-term chronic emissions or short-term acute impacts associated with the accident scenario. As discussed in Section 5, the probability of direct impacts to the Monocacy as a result of an accident are so low as to be considered implausible. Thus, the most likely potential impacts to the aquatic receptors are related to the long-term chronic emissions. These emissions may result in direct deposition of emissions on the surface water body and the erosion of soils, impacted by deposition, into the surface water.

In Section 3, total surface water concentrations (dissolved and suspended sediment concentrations) associated with chronic deposition of air emissions were calculated. These concentrations assume the accumulation of emissions into the Monocacy Creek watershed for 35 years and then the constant erosion and deposition into the surface water body. It was assumed that there is no depletion of the watershed soil concentrations as a result of the erosion. The calculated surface water concentrations were determined for metals and those chemicals that have a high toxicity and food chain bioaccumulation potential (i.e, those chemicals carried forward into the analysis of indirect human exposure pathways as defined in Section 3). The potential effect on the aquatic receptors was determined by comparing the surface water concentrations to the chronic aquatic water quality criteria (Table 6-1). As shown in Table 6-1, the concentrations do not exceed the criteria. Hence, no long term chronic impacts are to be expected.

Additionally, higher food chain impacts were considered in this assessment. Although no threatened and endangered species were identified in the vicinity of the facility as per PA code §269.50, the bald eagle was nonetheless considered in this assessment because of its special status and its presence within the nearby Delaware River watershed area. However, the habitat quality near the facility and the relatively limited fishery in Monocacy Creek, as compared to the Delaware River, probably reduce the likelihood that bald eagles are singly dependent upon the Monocacy as a resource for prey. Thus, from a qualitative perspective, it is unlikely that there are risks to bald eagles that might be associated with facility air emissions, due to the limited site use of the facility area by these predators.

In summary, the facility air emissions have been evaluated to determine the potential impacts to ecological receptors in the vicinity of the Keystone facility. The principal habitat that might be impacted was determined to be the aquatic species in the Monocacy Creek under long-term chronic deposition of facility air emissions. Impacts associated with these emissions were determined by comparing the total surface water concentrations (determined in Section 3.7) to aquatic water quality criteria. No exceedance of the criteria were found, so long-term impacts on aquatic species in Monocacy Creek are unlikely.

Table 6-1

Comparison of Chronic Ambient Water Quality Criteria to Estimated Surface Water Concentrations

Chemical	Surface Water Concentrations (µg/L)[a]	Chronic AWQC (µg/L)[k]
Metals		
Aluminum	3.42E-04	---
Antimony	5.27E-08	30[a]
Arsenic	4.81E-08	190[b]
Barium	2.50E-05	---
Beryllium	8.02E-08	5.3[c]
Cadmium	1.83E-05	1[d]
Chromium (III)	3.66E-05	180[d]
Chromium (VI)	2.11E-08	10[b]
Copper	5.52E-06	11[d]
Lead	2.18E-04	2.5[d]
Manganese	4.93E-06	---
Mercury, inorganic	1.05E-06	0.012[e]
Nickel	9.70E-06	160[d]
Selenium	7.81E-08	5[f]
Silver	1.50E-07	0.12[g]
Thallium	3.11E-07	40[c]
Zinc	7.18E-05	100[d]
Semi-Volatiles		
Bis(2-ethylhexyl)phthalate	4.26E-08	3[h]
PCBs		
Nonachlorobiphenyl	4.55E-11	0.014[i]
Decachlorobiphenyl	5.76E-11	0.014[i]

Table 6-1

Comparison of Chronic Ambient Water Quality Criteria to Estimated Surface Water Concentrations

Chemical	Surface Water Concentrations (μg/L)*	Chronic AWQC (μg/L)[k]
Dioxins/Furans		
2,3,7,8-TCDD	1.76E-13	0.00001[j]
1,2,3,7,8-PeCDD	4.22E-13	0.00001[j]
1,2,3,4,7,8-HxCDD	2.04E-13	0.00001[j]
1,2,3,6,7,8-HxCDD	3.62E-13	0.00001[j]
1,2,3,7,8,9-HxCDD	6.02E-13	0.00001[j]
1,2,3,4,6,7,8-HpCDD	9.58E-13	0.00001[j]
OCDD	1.13E-12	0.00001[j]
2,3,7,8-TCDF	6.33E-13	0.00001[j]
1,2,3,7,8-PeCDF	7.95E-13	0.00001[j]
2,3,4,7,8-PeCDF	1.21E-12	0.00001[j]
1,2,3,4,7,8-HxCDF	1.91E-12	0.00001[j]
1,2,3,6,7,8-HxCDF	8.38E-13	0.00001[j]
2,3,4,6,7,8-HxCDF	1.03E-12	0.00001[j]
1,2,3,7,8,9-HxCDF	3.76E-14	0.00001[j]
1,2,3,4,6,7,8-HpCDF	1.71E-12	0.00001[j]
1,2,3,4,7,8,9-HpCDF	1.84E-13	0.00001[j]
OCDF	3.49E-13	0.00001[j]

*Dissolved and bound to suspended sediment
[a]proposed 1991; no value 1996
[b]function of water effect ratio
[c]1991 LOEL; no value 1996
[d]function of total hardness (based on CaCo3=100μg/L)
[e]not specified as inorganic; total recoverable
[f]total recoverable
[g]1991;no value 1996
[h]phthalate esters 1991 LOEL; no value 1996
[i]general PCB value
[j]dioxins LOEL 1991; no value 1996
[k]EPA, 1991, 1996b

Attachment 3

RCRA Soil Investigation Report

RCRA SOIL INVESTIGATION REPORT

Solid Waste Management Units #21, #22, #23, #32, #26, #29, #30, and Area B

Keystone Cement Company
Permit #: PAD 00 238 9559
Route 329
East Allen Township, Northampton County
Bath, PA 18014

September 2001

Prepared for:
Keystone Cement Company
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Bath, PA 18014

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ERG

5.0 CONCLUSIONS AND RECOMMENDATIONS

The following paragraphs present ERG's conclusions regarding the completed soils investigation, including recommendations for future facility actions.

5.1 Former Bermed Drum Storage Area (SWMU #21), Grease Drum Cleaning Area (SWMU #22), Grease Drum Discharge Tank (SWMU #23), and Packhouse Scrap Yard (SWMU #32)

Investigation actions were completed in the vicinity of SWMUs #21, #22, #23, & #32 to confirm past remedial activities. Eight (8) soil borings (21-1 through 21-5 & 32-1 through 32-3) were installed on June 25-26, 2001 around the perimeter of those areas listed above to the underlying natural silty clay. The borings were completed through the stone fill and cement kiln dust that covers the area.

PID field screening readings ranged from 0.0 to 0.3 parts per million (ppm) during installation of the eight (8) soil borings. Background PID readings were observed to range from 0.0 to 0.3 ppm. In addition, during installation of the borings, stained soils, free product or odors were not observed.

Based upon review of the field screening data, lithologic logs and soil analytical data, ERG concludes that the soils located in the vicinity of SWMU Areas #21, #22, #23, & #32 do not possess elevated levels of target parameters above applicable Act 2 MSCs or other indications of historical impacts and, therefore confirm the past remedial activities. Therefore, ERG recommends that no further actions are required for these areas.

5.2 Former Waste Oil Filter Drum Staging Area (SWMU # 26)

Investigation actions were completed in the vicinity of SWMU #26 to confirm past remedial activities. Six (6) soil borings (26-1 through 26-6) were installed on June 25, 2001 around the perimeter of the concrete pad covering this area to the underlying natural silty clay. The borings were completed through the stone fill that covers the area to the underlying silty clay.

PID field screening readings ranged from 0.0 to 41.1 ppm during installation of the six (6) soil borings. Background PID readings were observed to be 0.3 ppm. Elevated PID readings were found in borings 26-2, 26-3, and 26-6. However, stained soils or free product were not observed in borings 26-2, 26-3, and 26-6. In addition, during installation of the other borings, stained soils, free product or odors were not observed.

Based upon review of the field screening data, lithologic logs and soil analytical data, ERG concludes that the soils located in the vicinity of SWMU #26 do not possess elevated levels of target parameters above applicable Act 2 MSCs or other indications of historical impacts and, therefore confirm the past remedial activities. Therefore, ERG recommends that no further actions are required for this area.

5.3 Former Coal Tar Storage Area (SWMU # 29)

Investigation actions were completed in the vicinity of SWMU #29 to confirm past remedial activities. Six (6) soil borings (29-1 through 29-6) were installed on June 25, 2001 in the area formerly used for storage of coal tar to the underlying natural silty clay. The borings were completed through the stone fill that covers the area.

PID field screening readings ranged from 0.0 to 0.1 ppm during installation of the six (6) soil borings. Background PID readings were observed to range from 0.0 to 0.1 ppm. In addition, during installation of the borings, stained soils, free product or odors were not observed.

Based upon review of the field screening data, lithologic logs and soil analytical data, ERG concludes that the soils located in the vicinity of SWMU #29 do not possess elevated levels of target parameters above applicable Act 2 MSCs or other indications of historical impacts and, therefore confirm the past remedial activities. Therefore, ERG recommends that no further actions are required for this area.

5.4 Former Railroad Car Storage Area (SWMU #30)

Investigation actions were completed in the vicinity of SWMU #30 to confirm past remedial activities. Six (6) soil borings (30-1 through 30-6) were installed on June 25, 2001 in the area formerly used as a railroad siding to stage railroad cars containing hazardous fuel liquids. The borings were completed through the stone fill and coal fines that cover the area.

PID field screening readings ranged from 0.0 to 1.5 ppm during installation of the six (6) soil borings. Background PID readings were observed to range from 0.0 to 0.3 ppm. In addition, during installation of the borings, stained soils, free product or odors were not observed.

Based upon review of the field screening data, lithologic logs and soil analytical data, ERG concludes that the soils located in the vicinity of SWMU #30 do not possess elevated levels of target parameters above applicable Act 2 MSCs or other indications of historical impacts and, therefore confirm the past remedial activities. Therefore, ERG recommends that no further actions are required for this area.

5.5 Former Oil Drum Storage Area (SWMU Area B)

Investigation actions were completed in the vicinity of SWMU Area B to confirm past remedial activities. Two (2) soil borings (B-1 and B-2) were installed on June 25, 2001 in the area formerly used to store oil drums. The borings were completed through the stone fill that covers the area.

PID field screening readings ranged from 0.0 to 0.7 ppm during installation of the two (2) soil borings. Background PID readings were observed to range from 0.0 to 0.3 ppm. In addition, during installation of the borings, stained soils, free product or odors were not observed.

Based upon review of the field screening data, lithologic logs and soil analytical data, ERG concludes that the soils located in the vicinity of SWMU Area B do not possess elevated levels of target parameters above applicable Act 2 MSCs or other indications of historical impacts and, therefore confirm the past remedial activities. Therefore, ERG recommends that no further actions are required for this area.

5.6 Summary

In summary, the soil investigation results presented herein indicate that soils sampled in the vicinity of the Former Bermed Drum Storage Area (SWMU #21), Grease Drum Cleaning Area (SWMU #22), Grease Drum Discharge Tank (SWMU #23), and Packhouse Scrap Yard (SWMU #32); the Former Waste Oil Filter Drum Staging Area (SWMU #26); the Former Coal Tar Storage Area (SWMU #29); the Former Railroad Car Storage Area (SWMU #30); and the Former Oil Drum Storage Area (SWMU Area B) do not possess levels of target analytes above applicable Act 2 MSCs or other indications of historical impacts and, therefore confirm the past remedial activities.

Based upon the results of the completed remedial and investigation actions, ERG and Keystone respectfully request that EPA require no further actions for SWMUs #21, #22, #23, #32, #26, #29, #30, and Area B located at the Keystone facility.

ERG has performed this study in a professional manner using that degree of skill and care exercised for similar projects under similar conditions by reputable and competent environmental consultants. The findings presented herein are based solely on the investigations and observations described within this report at the time the investigation was performed. Future events at the site or the surrounding properties may alter these findings. No other warranty, expressed or implied, is made as to the professional opinions included by ERG in this Report.

Attachment 4
Ground Water Monitoring

Monitoring Points	Date Sampled	Comments	Ammonia -Nitrogen (MG/L)	Bicarbonate (MG/L)	Ca - Total (MG/L)	Ca - Diss (MG/L)	COD (MG/L)	Chloride (MG/L)	Fluoride (MG/L)	Iron - Total (MG/L)	Iron - Diss (MG/L)	Mg - Total (MG/L)	Mg - Diss (MG/L)	Mn - Total (MG/L)	Mn - Diss (MG/L)	K - Total (MG/L)	K - Diss (MG/L)	NO3-N (MG/L)	pH (field) units	pH (lab) units	Na - Total (MG/L)	Na - Diss (MG/L)	Spec Cond (field) (UMHOS/CM)	Spec Cond (lab) (UMHOS/CM)	Sulfate (MG/L)	Alkalinity (MG/L)	TDS (MG/L)	TOC (MG/L)	Turbidity (NTU)
CKD-1	06/11/97	14R-Annual	0.12	233	99	99	<10	31	<0.1	3.1	0.07	32	32	0.07	<0.01	11	10	3.05	7.8	7.7	22.5	23	1190	1050	290	234	765	<1	42
CKD-1	09/17/97	14R-Qrtrly	<0.05	261	140	140	<10	33	<0.1	0.91	0.07	NA	NA	0.02	<0.01	11	11	2.72	7.82	7.8	35.8	36.8	1120	981	330	262	800	1.3	12
CKD-1	12/10/97	14R-Qrtrly	<0.05	236	135	135	<10	34	<0.1	0.16	<0.05	NA	NA	<0.01	<0.01	8.6	8.6	2.49	7.4	8	29.2	30	1270	1210	350	239	842	<1	4.8
CKD-1	02/03/98	Qrtrly	0.12	296	155	152	<10	33	<0.1	0.62	<0.05	NA	NA	0.02	<0.01	8.9	8.5	2.14	7.4	7.7	32.9	32.5	1440	1270	370	297	910	<1	8.2
CKD-1	05/04/98	14R-Annual	0.2	260	172	170	<100	57	0.071	0.26	<0.05	39	40	<0.05	<0.05	16.4	12.9	0.73	8.13	7.01	30	31.8	1344	1200	270	260	812	<1	1.34
CKD-1	08/05/98	14R-Qrtrly	<0.1	280	154	143	<100	43	0.056	1.9	0.089	NA	NA	<0.01	<0.01	10	10	2.5	7.89	7.12	58	60	1405	1200	360	280	830	<1	41.5
CKD-1	11/10/98	14R-Qrtrly	<0.1	246	163	146	<100	43	0.1	0.44	0.02	NA	NA	0.01	<0.01	12	10	2.8	6.9	7.02	44	39	1166	1102	340	246	768	<1	10
CKD-1	02/04/99	Qrtrly	<0.1	290	180	180	<100	44.3	0.041	0.85	<0.02	NA	NA	0.014	<0.01	8.1	7.6	2.5	7	7.08	37	37	1219	1300	330	290	900	<1	28
CKD-1	05/04/99	14R-Annual	0.29	270	150	160	<100	44.3	0.044	0.32	<0.01	40	44	0.006	<0.005	9.4	9.7	2.68	6.9	7.23	32	35	1090	1200	300	270	820	<3	11.2
CKD-1	08/03/99	14R-Qrtrly	<0.1	280	90	110	<50	32	0.08	0.14	<0.01	NA	NA	<0.005	<0.005	8.7	10	3.3	7	7.14	79	97	799	1100	240	280	760	1.66	5.5
CKD-1	11/02/99	14R-Qrtrly	0.13	280	150	160	<50	36	0.1	0.066	<0.01	NA	NA	0.006	<0.005	10	9.8	3.3	6.5	8.9	55	57	972	1200	300	280	830	<1	12
CKD-1	02/01/00	14R-Qrtrly	<0.05	301	156	158	<15	38	<0.1	0.9	<0.03	NA	NA	0.01	<0.01	9.2	9	2.07	6.9	6.1	38.9	40.5	866	1120	420	301	898	1.7	26
CKD-1	05/03/00	Qrtrly	<0.05	296	162	151	<15	40	<0.1	1.4	0.34	NA	NA	0.06	0.03	8.1	8.5	1.18	7.3	7	38.7	39.6	512	993	390	296	923	<1	32
CKD-1	08/01/00	14R-Annual	<0.05	282	150	144	<15	35	<0.1	0.6	0.06	33.9	33.1	0.02	0.01	10	9.3	3.02	6.8	7.5	51.6	52.5	1210	1180	320	283	844	<1	26
CKD-1	11/06/00	14R-Qrtrly	<0.05	295	180	141	<15	42	<0.1	12.5	0.05	NA	NA	0.29	<0.01	9.6	9.1	2.35	8.8	7.8	46.3	44.7	1260	1150	370	297	850	1	20
CKD-1	02/28/01	14R-Qrtrly	<0.05	301	194	173	<15	41	<0.1	0.72	0.04	44.8	40.5	0.03	<0.01	9	9.3	1.65	6.9	7.7	38	38.5	1310	1290	420	302	952	<1	68
CKD-1	05/30/01	Qrtrly	<0.05	281	147	145	<15	51	<0.1	3	<0.03	34.4	33.3	0.08	<0.01	9.8	9.1	2.28	6.7	7.4	40	38.1	1200	1190	316	282	818	<1	4.7
CKD-1	08/21/01	14R-Annual	<0.05	283	139	143	<15	38	<0.1	0.24	<0.03	34.8	35.8	<0.01	<0.01	14	14	2.74	6.75	7.6	57.1	59.6	1220	1210	326	284	832	1.1	12
CKD-1	11/28/01	Qrtrly	<0.05	290	172	169	<15	45	<0.1	0.07	<0.03	43.3	42.6	<0.01	<0.01	10	9.9	2.94	6.7	7.8	44.1	44	1340	1350	409	292	916	1.2	2.8
CKD-2	06/11/97	14R-Annual	0.16	136	77.7	80.4	<10	12	<0.1	27.1	<0.05	22	20	1.2	<0.01	15	12	2.19	7.3	7.4	7.6	8.1	853	753	240	136	539	<1	210
CKD-2	09/17/97	14R-Qrtrly	<0.05	130	87.7	84.1	<10	11	<0.1	31.2	0.2	NA	NA	1.22	<0.01	17	13	2.08	8.01	7.4	6.7	7	735	779	250	131	530	<1	290
CKD-2	12/10/97	14R-Qrtrly	<0.05	152	151	92.1	<10	13	<0.1	392.3	0.4	NA	NA	16.4	0.02	43	13	2.15	7.4	7.4	7.6	7	738	775	220	153	505	2	6800
CKD-2	02/03/98	Qrtrly	0.08	127	108	103	<10	8	<0.1	68.3	<0.05	NA	NA	2.69	<0.01	21	17	1.76	7.2	7.2	6.2	6.4	860	822	280	128	577	<1	200
CKD-2	05/04/98	14R-Annual	<0.1	110	120	110	<100	35	0.071	0.54	<0.05	50	23	0.07	<0.05	16	17	1.7	7.32	6.63	7.2	9	798	810	330	110	540	<1	2.04
CKD-2	08/05/98	14R-Qrtrly	<0.1	120	100	86	<100	14	0.067	1.1	<0.03	NA	NA	<0.01	<0.01	16	17	2.1	7.37	6.98	7.7	7.3	799	750	250	120	560	<1	21
CKD-2	11/10/98	14R-Qrtrly	<0.1	129	95	88	<100	34	0.12	0.46	<0.02	NA	NA	0.014	<0.01	13	11	2.2	6.6	7	9.4	9.3	626	299	170	129	432	<1	11
CKD-2	02/04/99	Qrtrly	<0.1	120	98	99	<100	<10	0.054	0.45	0.14	NA	NA	0.016	<0.01	16	17	1.6	6.6	6.73	5.8	6.2	572	710	330	120	540	<1	7.8
CKD-2	05/04/99	14R-Annual	<0.1	140	91	100	<100	10.6	0.056	0.34	<0.01	18	20	0.012	<0.005	13	14	2.1	6.7	6.88	6.9	8.3	536	700	190	140	460	<3	10.5
CKD-2	08/03/99	14R-Qrtrly	Well Was Dry, No Sample Obtained																										
CKD-2	11/02/99	14R-Qrtrly	Well Was Dry, No Sample Obtained																										
CKD-2	02/01/00	14R-Qrtrly	<0.05	139	93.8	73.5	<15	15	<0.1	99.8	<0.03	NA	NA	3.34	<0.01	22	11	2		6	8.5	8.9	NA	621	210	139	444	1.6	575
CKD-2	05/03/00	Qrtrly	<0.05	119	94.7	89.8	<15	11	<0.1	0.08	<0.03	NA	NA	0.01	<0.01	16	16	2.09	6.8	6.5	6.6	8.8	468	567	220	119	504	<1	7.5
CKD-2	08/01/00	14R-Annual	<0.05	119	89.3	88.2	<15	12	<0.1	0.08	<0.03	16.1	16.1	<0.01	<0.01	15	16	2.06	6.4	7	6.7	7.6	659	651	190	119	448	1.1	4
CKD-2	11/06/00	14R-Qrtrly	<0.05	132	69.8	76.5	<15	18	<0.1	0.65	<0.03	NA	NA	0.01	<0.01	11	12	2.28	6.7	7.3	8.5	8.9	633	602	170	132	378	<1	3.1
CKD-2	02/28/01	14R-Qrtrly	<0.05	130	90.4	92.3	<15	18	<0.1	1.2	<0.03	16.6	16.8	0.06	<0.01	14	15	1.7	7	7.3	6.9	6.9	670	638	180	130	434	<1	170
CKD-2	05/30/01	Qrtrly	<0.05	119	90.9	90.4	<15	11	<0.1	0.04	<0.03	15.4	15.5	<0.01	<0.01	15	15	1.8	6.5	6.9	6	8.1	672	668	210	120	438	<1	2.3
CKD-2	08/21/01	14R-Annual	<0.05	133	81.6	80.3	<15	21	<0.1	0.04	<0.03	18	17.8	<0.01	<0.01	12	11	2.54	6.31	7.3	10.8	10.8	636	641	159	133	434	<1	1.8
CKD-2	11/28/01	14R-Qrtrly	Well Was Dry, No Sample Obtained																										
CKD-3	06/11/97	14R-Annual	0.22	302	72.8	70.5	<10	<1	<0.1	1.1	0.09	42	38	0.04	0.02	2.8	2.9	5.41	8.2	8	3.5	3.5	1300	781	97	304	523	<1	58
CKD-3	09/17/97	14R-Qrtrly	<0.05	297	84.8	80.8	<10	12	<0.1	0.4	0.12	NA	NA	0.03	0.02	2.4	2.2	3.89	8.12	8	3.7	3.9	674	772	110	299	470	1.4	9.3
CKD-3	12/10/97	14R-Qrtrly	<0.05	321	102	97.6	<10	13	<0.1	0.9	<0.05	NA	NA	0.04	0.03	3	3.8	2.37	7.4	7.9	3.8	4.6	904	884	140	323	554	<1	9.5
CKD-3	02/03/98	Qrtrly	0.05	298	90.9	91.9	<10	14	<0.1	0.62	<0.05	NA	NA	0.04	0.01	2.4	2.4	3.57	7.5	7.8	3.8	4.4	868	819	110	300	501	<1	18
CKD-3	05/04/98	14R-Annual	0.23	290	120	110	<100	32	0.075	0.8	<0.05	49	47	0.1	<0.05	6.9	5.5	1.7	8.23	7.28	7.3	6.98	825	860	130	290	520	<1	2.02
CKD-3	08/05/98	14R-Qrtrly	0.13	310	125	108	<100	28	0.08	1.9	0.03	NA	NA	<0.01	<0.01	8.2	6.5	2.7	6.75	7.28	7.2	6.3	954	930	160	310	644	1.4	58.2
CKD-3	11/10/98	14R-Qrtrly	<0.1	295	123	117	<100	41	0.12	3.7	<0.02	NA	NA	0.096	0.036	5.6	4.9	2.2	7.2	7.17	6.7	7.5	857	917	150	295	592	<1	62
CKD-3	02/04/99	Qrtrly	<0.1	310	100	130	<100	39	0.036	8.4	<0.02	NA	NA	0.26	<0.01	6.5	3	4.6	7.2	7.22	7.7	7.1	975	1000	190	310	640	<1	220
CKD-3	05/04/99	14R-Annual	<0.1	310	140	140	<100	35.5	0.053	2.3	<0.01	55	56	0.025	0.008	6	5.2	2.96	7.2	7.2	7.3	8.2	973	1000	190	310	710	<3	82.8
CKD-3	08/03/99	14R-Qrtrly	<0.1	270	120	120	<50	50	0.05	6.2	<0.01	NA	NA	0.062	<0.005	4.4	3.8	4.6	6.8	7.29	7.3	8.7	872	940	170	270	660	2.28	220
CKD-3	11/02/99	14R-Qrtrly	0.1	280	120	130	<50	53	0.08	0.099	<0.01	NA	NA	0.009	<0.005	2.5	3.2	4.2	6.7	7.22	8.5	9.5	778	990	170	280	640	<1	99
CKD-3	02/01/00	14R-Qrtrly	<0.05	287	125	121	<15	50	<0.1	0.66	0.04	NA	NA	<0.01	<0.01	4	2.9	3.77	6.9	6.5	8.5	10.9	850	958	240	287	692	1.7	22
CKD-3	05/03/00	Qrtrly	<0.05	324	163	156	<15	43	<0.1	0.26	<0.03	NA	NA	<0.01	<0.01	6	5.2	4.74	7.2	7.1	9.1	10.3	613	971	330	324	991	<1	20
CKD-3	08/01/00	14R-Annual	<0.05	299	156	164	<15	62	<0.1	0.18	<0.03	62.8	61.8	<0.01	<0.01	7.6	7.3	5.04	6.9	7.7	13	13.8	1300	1230	300	301	952	1.1	20
CKD-3	11/06/00	14R-Qrtrly	<0.05	321	149	134	<15	69	0.2	3	0.11	NA	NA	0.02	<0.01	12	10	4.01	6.9	8	14.8	14.2	1330	1250	340	324	870	<1	76
CKD-3	02/28/01	14R-Qrtrly	<0.05	311	243	218	<15	78	<0.1	0.34	<0.03	73.4	65.6	<0.01	<0.01	7.2	6.5	4.05	6.8	7.7	18.9	17	1810	1460	600	313	1270	<1	5
CKD-3	05/30/01	Qrtrly	<0.05	306	211	201	<15	75	<0.1	0.1	<0.03	65.9	63.9	<0.01	<0.01	6.3	6.2	5.24	7.1	7.3	16.3	16	1530	1560	514	306	1190	<1	80

Monitoring Points	Date Sampled	Comments	Ammonia-Nitrogen (MG/L)	Bicarbonate (MG/L)	Ca - Total (MG/L)	Ca - Diss (MG/L)	COD (MG/L)	Chloride (MG/L)	Fluoride (MG/L)	Iron - Total (MG/L)	Iron - Diss (MG/L)	Mg - Total (MG/L)	Mg - Diss (MG/L)	Mn - Total (MG/L)	Mn - Diss (MG/L)	K - Total (MG/L)	K - Diss (MG/L)	NO3-N (MG/L)	pH (field) units	pH (lab) units	Na - Total (MG/L)	Na - Diss (MG/L)	Spec Cond (field) (UMHOS/CM)	Spec Cond (lab) (UMHOS/CM)	Sulfate (MG/L)	Alkalinity (MG/L)	TDS (MG/L)	TOC (MG/L)	Turbidity (NTU)
CKD-3	08/21/01	14R-Annual	<0.05	287	165	165	<15	90	<0.1	0.19	<0.03	74.1	69.7	<0.01	<0.01	6.9	7.2	5.03	6.87	7.8	22.4	20.7	1410	1440	388	288	1050	<1	18
CKD-3	11/28/01	Qrtrly	<0.05	277	172	163	<15	111	<0.1	0.07	<0.03	73.5	69.8	<0.01	<0.01	5.3	5	5.23	7	7.6	22.4	21.4	1370	1420	313	278	922	<1	17
CKD-4	06/11/97	14R-Annual	<0.05	258	83.9	79.4	<10	15	<0.1	0.1	0.14	33	31	0.02	<0.01	5.3	4.9	2.61	7.5	7.9	8.2	8.1	913	821	160	259	574	<1	13
CKD-4	09/17/97	14R-Qrtrly	<0.05	258	108	102	<10	19	<0.1	1.7	0.23	NA	NA	0.03	0.03	5.9	5.8	3.26	7.84	7.9	10.6	10.5	815	890	170	260	549	<1	24
CKD-4	12/10/97	14R-Qrtrly	<0.05	234	101	99	<10	38	<0.1	2.1	<0.05	NA	NA	0.04	<0.01	9.4	8.6	3.59	7.4	7.9	15.9	16.8	1020	946	200	236	603	<1	25
CKD-4	02/03/98	Qrtrly	<0.05	234	103	99.1	<10	35	<0.1	8.1	0.17	NA	NA	0.15	<0.01	12	11	3.48	7.5	7.8	17.1	19	960	927	190	235	600	<1	120
CKD-4	05/04/98	14R-Annual	0.52	260	100	100	<100	43	0.062	0.2	<0.05	40	37	<0.05	<0.05	10	7	1.5	8.06	7.25	8	9.8	814	820	140	260	470	<1	1.21
CKD-4	08/05/98	14R-Qrtrly	<0.1	260	93	84	<100	14	0.041	2	1.9	NA	NA	<0.01	<0.01	5	5.1	2.8	8.42	7.33	7.8	7.7	989	760	120	260	460	<1	45
CKD-4	11/10/98	14R-Qrtrly	1.3	229	106	107	<100	40	0.076	0.11	<0.02	NA	NA	<0.01	<0.01	5	6.7	3.8	7.1	7.23	8.7	8.9	781	781	120	229	512	<1	3.4
CKD-4	02/04/99	Qrtrly	<0.1	240	140	97	<100	16	0.032	0.6	<0.02	NA	NA	0.065	<0.01	4.9	4.3	4.5	7.4	7.33	6.4	8.4	691	750	110	240	470	<1	330
CKD-4	05/04/99	14R-Annual	<0.1	240	110	110	<100	31.9	0.034	0.038	<0.01	34	38	<0.005	<0.005	6	6	3.76	7.3	7.34	10	12	766	840	140	240	540	<3	5.4
CKD-4	08/03/99	14R-Qrtrly	<0.1	240	120	110	57	34	0.05	29	<0.01	NA	NA	0.61	<0.005	10	6.5	5.2	6.6	7.09	11	13	475	870	160	240	670	2.07	330
CKD-4	11/02/99	14R-Qrtrly	0.11	260	100	110	<50	36	0.06	0.031	<0.01	NA	NA	<0.005	<0.005	7.5	8.6	4.6	6.1	7.18	15	16	712	910	190	260	620	<1	2.5
CKD-4	02/01/00	14R-Qrtrly	<0.05	253	112	112	<15	41	<0.1	0.21	<0.03	NA	NA	<0.01	<0.01	8	7.8	4.94	7.1	6.5	14.5	15	705	885	210	253	616	1.4	3.6
CKD-4	05/03/00	Qrtrly	<0.05	263	103	111	<15	32	<0.1	0.07	<0.03	NA	NA	<0.01	<0.01	6.6	7.8	5.1	7.4	7.2	12.5	14.7	324	724	160	263	677	<1	2.5
CKD-4	08/01/00	14R-Annual	<0.05	256	97	99.7	<15	21	<0.1	0.1	<0.03	34.8	35.8	<0.01	<0.01	6.2	6.4	4.54	7	7.7	9.7	11.4	807	804	140	258	539	<1	4.5
CKD-4	11/06/00	14R-Qrtrly	<0.05	262	83.9	91.9	<15	17	<0.1	0.15	<0.03	NA	NA	<0.01	<0.01	5.7	5.7	3.92	6.9	7.8	8.3	9.5	757	722	120	263	444	<1	0.8
CKD-4	02/28/01	14R-Qrtrly	<0.05	234	101	102	<15	24	<0.1	<0.03	<0.03	35.3	35.3	<0.01	<0.01	6.4	6.5	4.6	7	8.3	9.8	9.8	809	786	130	239	502	<1	1.7
CKD-4	05/30/01	Qrtrly	<0.05	267	121	121	<15	45	<0.1	<0.03	<0.03	44.7	44.7	<0.01	<0.01	15	15	5.11	6.8	7.5	16.9	16.9	1020	1010	210	268	660	<1	0.9
CKD-4	08/21/01	14R-Annual	<0.05	255	95.5	94.7	<15	21	<0.1	0.05	<0.03	36.7	36.3	<0.01	<0.01	9.6	10	4.72	6.78	7.8	11.8	11.9	788	795	129	257	524	<1	1.5
CKD-4	11/28/01	14R-Qrtrly	Well Was Dry, No Sample Obtained																										
EPA STANDARD			--------	--------	--------	--------	--------	--------	4	0.3*	0.3*			0.05*	0.05*	--------	--------	10	-2	-2	--------	--------	--------	--------	250 *	--------	500 *	--------	0.5 - 1.0 NTU ERR
PA DEP STANDARD			--------	--------	--------	--------	--------	--------	2	0.3*	0.3*			0.05*	0.05*	--------	--------	10	--------	--------	--------	--------	--------	--------	500	--------	--------	--------	--------
REGIONAL VALUES (Wood, 1972)			--------	-153	-102	--------	--------	-93.1	-0.2	-160	--------			-0.65	--------	-20.7	--------	-53.9	-0.7	-1.6	-33.3	--------	-600	-800	-379	--------	-608	--------	--------
Trip Blank	06/11/97	14R-Annual	<0.05	1	<0.1	<0.1	<10	<1	<0.1	<0.05	<0.05	NA	NA	<0.01	<0.01	<0.2	<0.2	<0.05	NA	5.3	<0.2	<0.2	NA	4	<10	1	<5	<1	<0.1
Trip Blank	09/17/97	Form 14R	<0.05	2	<0.1	<0.1	<10	<10	<0.1	<0.05	<0.05	NA	NA	<0.01	<0.01	<0.2	<0.2	<0.05	NA	5.5	<0.2	<0.2	NA	3	<10	2	5	<1	0.2
Trip Blank	12/10/97	Form 14R	<0.05	2	<0.1	<0.1	<10	<1	<0.1	<0.05	<0.05	NA	NA	<0.01	<0.01	<0.2	<0.2	<0.05	NA	5.4	<0.2	<0.2	NA	7	<10	2	<5	<1	0.1
Trip Blank	02/03/98	Form 14R	<0.05	2	<0.1	<0.1	<10	<1	<0.1	<0.05	<0.05	NA	NA	<0.01	<0.01	<0.2	<0.2	<0.05	NA	5.5	<0.2	<0.2	NA	7	<10	2	<5	<1	0.2
Trip Blank	05/03/00	Form 14R	<0.05	2	<0.1	0.2	<15	<1	<0.1	0.06	0.05	NA	NA	<0.01	<0.01	<0.2	<0.2	<0.05	NA	5	<0.2	<0.2	NA	3	<10	2	<5	<1	0.3
Trip Blank	05/30/01	Form 14R	<0.05	<5	0.2	0.1	<15	<1	<0.1	<0.03	<0.03	<0.1	<0.1	<0.01	<0.01	<0.2	<0.2	<0.05	NA	5.1	<0.2	<0.2	NA	4	<10	<5	<10	<1	0.3
Trip Blank	11/28/01	14R	<0.05	<5	0.1	0.1	<15	<1	<0.1	<0.03	<0.03	<0.1	<0.1	<0.01	<0.01	<0.2	<0.2	<0.05	NA	5.3	<0.2	<0.2	NA	3	<10	<5	<10	<1	0.2
Equipment Blank	05/30/01	Form 14R	<0.05	11	3.8	0.3	<15	1	<0.1	<0.03	<0.03	1.9	<0.1	<0.01	<0.01	0.3	<0.2	<0.05	NA	7.1	1.6	<0.2	NA	28	<10	11	<10	<1	0.3
Equipment Blank	08/21/01	14R-Annual	<0.05	<5	0.2	0.2	<15	<1	<0.1	<0.03	<0.03	<0.1	<0.1	<0.01	<0.01	<0.2	<0.2	0.37	NA	5.9	<0.2	<0.2	NA	2	<10	<5	14	<1	0.4
Equipment Blank	11/28/01	Form 14R	<0.05	<5	<0.1	0.2	<15	<1	<0.1	<0.03	<0.03	<0.1	<0.1	<0.01	<0.01	<0.2	<0.2	<0.05	NA	5.5	<0.2	<0.2	NA	2	<10	<5	<10	<1	0.3

References:

Wood, Charles R., et al. Water Resources Report 31: Water Resources of Lehigh County, Pennsylvania. Pennsylvania Geological Survey. Fourth Series. Harrisburg, PA. 1972

Monitorin Points	Date Sampled	Comment	As - Total (µG/L)	As - Diss (µG/L)	Ba - Total (µG/L)	Ba - Diss (µG/L)	Cd - Total (µG/L)	Cd - Diss (µG/L)	Cr - Total (µG/L)	Cr - Diss (µG/L)	Cu - Total (µG/L)	Cu - Diss (µG/L)	Lead - (µG/L)	Lead - D (µG/L)	Hg - Tot (µG/L)	Hg - Dis (µG/L)	Se - Total (µG/L)	Se - Diss (µG/L)	Ag - Total (µG/L)	Ag - Diss (µG/L)	Zn - Total (µG/L)	Zn - Diss (µG/L)
EPA STANDARD			50	50	2000	2000	5	5	100	100	1000	1000	5	15	2	2	50	50	100 *	0.1 *	5000 *	5000 *
PA DEP STANDARD			50	50	2000	2000	5	5	100	100	1000	1000	5	5	2	2	50	50	100	100 **	2000 **	2000 **
CKD-1	06/11/97	14R-Annu	<50	<50	90	90	<5	<5	<10	<10	<10	<10	<15	<15	<0.2	<0.2	3	3	<10	<10	7	11
CKD-1	05/04/98	14R-Annu	<10	<10	<500	<500	<10	<10	<10	<10	<50	<50	<5	<5	<2	<2	<10	<10	<50	<50	<500	<500
CKD-1	05/04/99	14R-Annu	<30	<30	48	96	<5	<5	<10	<10	<10	<10	<5	<5	<1	<1	<50	<50	<10	<10	11	11
CKD-1	08/01/00	14R-Annu	<50	<50	60	50	<5	<5	<10	<10	<10	<10	<5	<5	<0.2	<0.2	4	3	<10	<10	<5	109
CKD-1	08/21/01	14R-Annu	<50	<50	60	60	<5	<5	<10	<10	<10	<10	<5	<5	<0.2	<0.2	4	3	<10	<10	8	<5
CKD-2	06/11/97	14R-Annu	<50	<50	130	40	<5	<5	20	<10	30	<10	<15	20	<0.2	<0.2	3	3	<10	<10	75	11
CKD-2	05/04/98	14R-Annu	<10	<10	<500	<500	<10	<10	<10	<10	<50	<50	<5	<5	<2	<2	<10	<10	<50	<50	<500	<500
CKD-2	05/04/99	14R-Annu	<30	<30	19	210	<5	<5	<10	<10	<10	<10	<5	<5	<1	<1	<50	<50	<10	<10	<10	69
CKD-2	08/01/00	14R-Annu	<50	<50	20	30	<5	<5	<10	<10	<10	<10	<5	<5	<0.2	<0.2	2	4	<10	<10	<5	19
CKD-2	08/21/01	14R-Annu	<50	<50	20	20	<5	<5	<10	<10	<10	<10	<5	<5	<0.2	<0.2	<2	<2	<10	<10	<5	<5
CKD-3	06/11/97	14R-Annu	<50	<50	90	70	<5	<5	<10	<10	<10	<10	<15	<15	<0.2	<0.2	3	2	<10	<10	6	8
CKD-3	05/04/98	14R-Annu	<10	<10	<500	<500	<10	<10	<10	<10	<50	<50	<5	<5	<2	<2	<10	<10	<50	<50	<500	<500
CKD-3	05/04/99	14R-Annu	<30	<30	74	250	<5	<5	11	<10	21	<10	<5	<5	<1	<1	<50	<50	<10	<10	14	67
CKD-3	08/01/00	14R-Annu	<50	<50	80	200	<5	<5	<10	<10	<10	<10	<5	<5	<0.2	<0.2	3	3	<10	<10	<5	90
CKD-3	08/21/01	14R-Annu	<50	<50	80	70	<5	<5	<10	<10	<10	<10	<5	<5	<0.2	<0.2	2	2	<10	<10	<5	<5
CKD-4	06/11/97	14R-Annu	<50	<50	60	60	<5	<5	<10	<10	<10	<10	<15	<15	<0.2	<0.2	2	<2	<10	<10	6	7
CKD-4	05/04/98	14R-Annu	<10	<10	<500	<500	<10	<10	<10	<10	<50	<50	<5	<5	<2	<2	<10	<10	<50	<50	<500	<500
CKD-4	05/04/99	14R-Annu	<30	<30	49	220	<5	<5	<10	<10	<10	<10	<5	<5	<1	<1	<50	<50	<10	<10	<10	42
CKD-4	08/01/00	14R-Annu	<50	<50	60	80	<5	<5	<10	<10	<10	<10	<5	<5	<0.2	<0.2	4	3	<10	<10	<5	398
CKD-4	08/21/01	14R-Annu	<50	<50	70	70	<5	<5	<10	<10	<10	<10	<5	<5	<0.2	<0.2	4	2	<10	<10	5	<5
Trip Blank	06/11/97	14R-Annu	<50	<50	<10	<10	<5	<5	<10	<10	<10	<10	<15	<15	<0.2	<0.2	<2	<2	<10	<10	<5	<5
Trip Blank	02/03/98	14R-Annu	<50	<50	<10	<10	<5	<5	<10	<10	<10	<10	<5	<5	<0.2	<0.2	<2	<2	<10	<10	<5	<5
Equipmen	08/21/01	14R-Annu	<50	<50	<10	<10	<5	<5	<10	<10	<10	<10	<5	<5	<0.2	<0.2	<2	<2	<10	<10	<5	<5
REGIONAL VALUES (Wood, 1			--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
CKD-1 (D	08/05/98	14R-Annu	<4	NA	61	NA	<0.2	NA	4.6	NA	<10	NA	<1	NA	<1	NA	<7	NA	<10	NA	<10	NA
CKD-1 (D	05/04/99	14R-Annu	<4	NA	58	NA	<0.2	NA	<4	NA	<10	NA	<1	NA	<1	NA	<7	NA	<10	NA	<10	NA
CKD-2 (D	08/05/98	14R-Annu	<4	NA	28	NA	<0.2	NA	<4	NA	<10	NA	<1	NA	<1	NA	<7	NA	<10	NA	<10	NA
CKD-2 (D	05/04/99	14R-Annu	<4	NA	24	NA	<0.2	NA	<4	NA	<10	NA	<1	NA	<1	NA	<7	NA	<10	NA	<10	NA
CKD-3 (D	08/05/98	14R-Annu	<4	NA	91	NA	<0.2	NA	11.1	NA	<10	NA	<1	NA	<1	NA	<7	NA	<10	NA	<10	NA
CKD-3 (D	05/04/99	14R-Annu	<4	NA	83	NA	<0.2	NA	9.6	NA	18	NA	1.3	NA	<1	NA	<7	NA	<10	NA	<10	NA
CKD-4 (D	08/05/98	14R-Annu	<4	NA	56	NA	<0.2	NA	<4	NA	<10	NA	<1	NA	<1	NA	<7	NA	<10	NA	<10	NA
CKD-4 (D	05/04/99	14R-Annu	<4	NA	62	NA	<0.2	NA	<4	NA	<10	NA	<1	NA	<1	NA	<7	NA	<10	NA	<10	NA

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Monitoring Points	Date Sampled	Benzene (µG/L)	1,2-Dibromoethane (µG/L)	1,1-Dichloroethane (µG/L)	1,1-Dichloroethene (µG/L)	1,2-Dichloroethane (µG/L)	Cis 1,2-dichloroethene (µG/L)	Trans 1,2 -Dichloroethene (µG/L)	Ethyl Benzene (µG/L)	Methylene Chloride (µG/L)	Tetrachloroethene (µG/L)	Toluene (µG/L)	1,1,1-Trichloroethane (µG/L)	Trichloroethene (µG/L)	Vinyl Chloride (µG/L)	Xylene (µG/L)
CKD-1	06/11/97	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<2	<5
CKD-1	05/04/98	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
CKD-1	05/04/99	<2	<2	<2	<2	<2	<2	<2	<2	8.3	<2	<2	<2	<2	<2	<2
CKD-1	08/01/00	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<2	<5
CKD-1	08/21/01	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<2	<5
CKD-2	06/11/97	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<2	<5
CKD-2	05/04/98	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
CKD-2	05/04/99	<2	<2	<2	<2	<2	<2	<2	<2	11	<2	<2	<2	<2	<2	26
CKD-2	08/01/00	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<2	<5
CKD-2	08/21/01	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<2	<5
CKD-3	06/11/97	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<2	<5
CKD-3	05/04/98	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
CKD-3	05/04/99	<2	<2	<2	<2	<2	<2	<2	<2	20	<2	<2	<2	<2	<2	<2
CKD-3	08/01/00	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<2	<5
CKD-3	08/21/01	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<2	<5
CKD-4	06/11/97	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<2	<5
CKD-4	05/04/98	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
CKD-4	05/04/99	<2	<2	<2	<2	<2	<2	<2	<2	21	<2	<2	<2	<2	<2	<2
CKD-4	08/01/00	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<2	<5
CKD-4	08/21/01	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<2	<5
Equipment Blank	05/04/99	<2	<2	<2	<2	<2	<2	<2	<2	18	<2	<2	<2	<2	<2	<2
Equipment Blank	08/03/99	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Trip Blank	06/11/97	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<2	<5
Trip Blank	02/03/98	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<2	<5
Trip Blank	08/21/01	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<2	<5
Equipment Blank	08/21/01	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<2	<5
EPA STANDARD		5	---------	---------	7	5	70	100	700	---------	5	1000	200	5	2	10000
PA DEP STANDARD		5	0.05	110	7	5	70	100	700	3 H	5	1000	200	5	2	10000

Monitoring Points	Date Sampled	Benzene (µG/L)	1,2-Dibromoethane (µG/L)	1,1-Dichloroethane (µG/L)	1,1-Dichloroethene (µG/L)	1,2-Dichloroethane (µG/L)	Cis 1,2-dichloroethene (µG/L)	Trans 1,2 -Dichloroethene (µG/L)	Ethyl Benzene (µG/L)	Methylene Chloride (µG/L)	Tetrachloroethene (µG/L)	Toluene (µG/L)	1,1,1-Trichloroethane (µG/L)	Trichloroethene (µG/L)	Vinyl Chloride (µG/L)	Xylene (µG/L)
REGIONAL VALUES (Wood, 1972)		---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------
CKD-1 (DEP)	08/05/98	0.019	<0.25	0.092	0.074	<0.25	0.059	<0.25	<0.25	<0.25	0.1	0.05	0.27	0.023	<0.25	<0.25
CKD-1 (DEP)	05/04/99	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<2	<1
CKD-2 (DEP)	08/05/98	0.019	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	0.046	<0.25	<0.25	<0.25	<0.25
CKD-2 (DEP)	05/04/99	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<2	<1
CKD-3 (DEP)	08/05/98	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	0.025	<0.25	<0.25	<0.25	<0.25
CKD-3 (DEP)	05/04/99	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<2	<1
CKD-4 (DEP)	08/05/98	0.019	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	0.016	0.044	0.024	<0.25	<0.25	<0.25
CKD-4 (DEP)	05/04/99	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<2	<1

Wood, Charles R., et al. Water Resources Report 31: Water Resources of Lehigh County, Pennsylvania. Pennsylvania Geological Survey. Fourth Series. Harrisburg, PA. 1972

CKD Annual Sampling Results - DEP Analysis

COMPOUND (ug/l)	CKD-1 (08/05/98	CKD-1 (05/04/99	CKD-2 (08/05/98	CKD-2 (05/04/99	CKD-3 (08/05/98	CKD-3 (05/04/99	CKD-4 (08/05/98	CKD-4 (DEP split) 05/04/99	
Acetone	<5	<5	<5	<5	<5	<5	<5	<5	
Bromobenzene	<0.25	<2	<0.25	<2	<0.25	<2	<0.25	<2	
Bromochloromethane	<0.25	NA	<0.25	NA	<0.25	NA	<0.25	NA	Chlorobromomethane; Methylene chlorobromide
Bromodichloromethane	<0.25	<1	<0.25	<1	<0.25	<1	<0.25	<1	
Bromoform	<0.25	<2	<0.25	<2	<0.25	<2	<0.25	<2	
Bromomethane	<0.25	<1	<0.25	<1	<0.25	<1	<0.25	<1	Methyl Bromide
2-BUTANONE	<2.5	<5	<2.5	<5	<2.5	<5	<2.5	<5	Methly Ethyl Ketone
n-Butybenzene	<0.25	<2	<0.25	<2	<0.25	<2	<0.25	<2	
Carbon Tetrachloride	<0.25	<1	<0.25	<1	<0.25	<1	<0.25	<1	
Chlorobenzene	<0.25	<1	<0.25	<1	<0.25	<1	<0.25	<1	
Chloroethane	<0.25	<1	<0.25	<1	<0.25	<1	<0.25	<1	Ethyl Chloride
Chloroform	<2	<1	<2	<1	<2	<1	<2	<1	
Chloromethane	<0.25	<2	<0.25	<2	<0.25	<2	<0.25	<2	Methyl Chloride
O-Chlorotoluene	<0.25	<2	<0.25	<2	<0.25	<2	<0.25	<2	
P-Chlorotolulene	<0.25	<2	<0.25	<2	<0.25	<2	<0.25	<2	
Dibromochloromethane	<0.25	<1	<0.25	<1	<0.25	<1	<0.25	<1	
1,2-Dibromo-3-chloropropane	<0.25	<2	<0.25	<2	<0.25	<2	<0.25	<2	
Dibromomethane	<0.25	<1	<0.25	<1	<0.25	<1	<0.25	<1	
1,2-Dichlorobenzene	<0.25	<2	<0.25	<2	<0.25	<2	<0.25	<2	
1,3-Dichlorobenzene	<0.25	<2	<0.25	<2	<0.25	<2	<0.25	<2	
1,4-Dichlorobenzene	<0.25	<2	<0.25	<2	<0.25	<2	<0.25	<2	
Dichlorodifluoromethane	<0.25	<2	<0.25	<2	<0.25	<2	<0.25	<2	
1,2-Dichloropropane	<0.25	<1	<0.25	<1	<0.25	<1	<0.25	<1	Propylene Dichloride
1,3-Dichloropropane	<0.25	<1	<0.25	<1	<0.25	<1	<0.25	<1	
2,2-Dichloropropane	<0.25	<1	<0.25	<1	<0.25	<1	<0.25	<1	
1,1-Dichloropropene	<0.25	NA	<0.25	NA	<0.25	NA	<0.25	NA	
cis-1,3-Dichlropropene	<0.25	<1	<0.25	<1	<0.25	<1	<0.25	<1	
trans-1,3-Dichlropropene	<0.25	<2	<0.25	<2	<0.25	<2	<0.25	<2	
1,1-Dimethylethylbenzene	<0.25	<2	<0.25	<2	<0.25	<2	<0.25	<2	tert-Butylbenzene
Hexachlorobutadiene	<0.25	<2	<0.25	<2	<0.25	<2	<0.25	<2	
2-HEXANONE	<2.5	<5	<2.5	<5	<2.5	<5	<2.5	<5	
4-ISOPROPYLTOLUENE	<0.25	<2	<0.25	<2	<0.25	<2	<0.25	<2	
2-METHOXY-2-METHYLPROPANE	<0.25	NA	<0.25	NA	<0.25	NA	<0.25	NA	
1-METHYLETHYLBENZENE	<0.25	<2	<0.25	<2	<0.25	<2	<0.25	<2	Isopropylbenzene
4-METHYL-2-PENTANONE	<2.5	<5	<2.5	<5	<2.5	<5	<2.5	<5	ANONE
1-METHYLPROPYLBENZENE	<0.25	<2	<0.25	<2	<0.25	<2	<0.25	<2	sec-Butylbenzene
Napthalene	<0.25	<2	<0.25	<2	<0.25	<2	<0.25	<2	
n-Propylbenzene	<0.25	<2	<0.25	<2	<0.25	<2	<0.25	<2	
Styrene	<0.25	<2	<0.25	<2	<0.25	<2	<0.25	<2	
1,1,1,2-Tetrachloroethane	<0.25	<1	<0.25	<1	<0.25	<1	<0.25	<1	
1,1,2,2-Tetrachloroethane	<0.25	<2	<0.25	<2	<0.25	<2	<0.25	<2	
1,2,3-Trichlorobenzene	<0.25	<1	<0.25	<1	<0.25	<1	<0.25	<1	
1,2,4-Trichlorobenzene	<0.25	<2	<0.25	<2	<0.25	<2	<0.25	<2	
1,1,2-Trichloroethane	<0.25	<1	<0.25	<1	<0.25	<1	<0.25	<1	
Trichlorofluoromethane	<0.25	<1	<0.25	<1	<0.25	<1	<0.25	<1	
1,2,3-Trichloropropane	<0.25	<2	<0.25	<2	<0.25	<2	<0.25	<2	
1,2,4-Trimethylbenzene	<0.25	<2	<0.25	<2	<0.25	<2	<0.25	<2	
1,3,5-Trimethylbenzene	<0.25	<2	<0.25	<2	<0.25	<2	<0.25	<2	
m/p-Xylene	<0.5	<2	<0.5	<2	<0.5	<2	<0.5	<2	
Vinyl Acetate	NA	<2	NA	<2	NA	<2	NA	<2	Ethenyl acetate
Tetrahydrofuran	NA	<1	NA	<1	NA	<1	NA	<1	
Methyl Tert-Butyl Ether	NA	<1	NA	<1	NA	<1	NA	<1	
1,1-Dichloro-1-propene	NA	<1	NA	<1	NA	<1	NA	<1	
Carbon Disulfide	NA	<1	NA	<1	NA	<1	NA	<1	